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THE

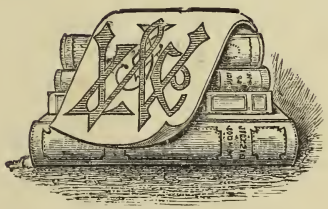
UNIVERSAL INSTRUCTOR

OR

Self-Culture for All.

VOL. II.

FULLY AND ACCURATELY ILLUSTRATED.



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THE

UNIVERSAL INSTRUCTOR;

OR

Self-Culture for all.

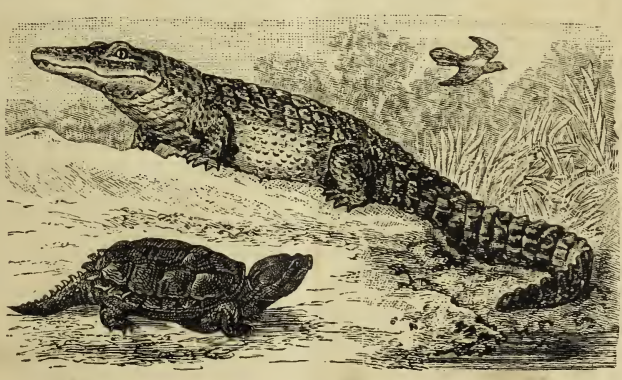
ZOOLOGY.

BY G. T. BETTANY, M.A., B.Sc.

INTRODUCTORY.

THE name given to our subject signifies the science or knowledge of animals; if we take it in its fullest sense, it includes every sort of knowledge about animals. More commonly it is limited, so as to deal particularly with that kind of information about animals which places them in an orderly arrangement, and which describes their outside appearances, and their history so far as it can be learnt by external observation. In these pages we shall not attempt to include or to exclude matter by any hard boundary line; but our endeavour will be to give such reasoning and such facts as may best conduce to an *understanding* of the animal creation. As far as possible the information possessed by every one will be appealed to, and the striking facts which occur about us every day, whether noticed or unnoticed, will be enlarged upon.

Classification and natural history.



SNAPPING TURTLE. (*Chelydra serpentina*). ALLIGATOR. (*Alligator Lucius*). MOCKING-BIRD. (*Orpheus polyglottus.*)

It is evident that we need to begin by getting a correct idea of what is meant by an animal. Every animal of course shares with every plant the characters of being alive. Each member of the living kingdom has a more complicated chemical composition than anything which is not alive. But further than this, it is especially noticeable that all living things are undergoing changes, whether quick or slow, and that these changes are unlike those of dead matter, for they occur in a regular order, and have a beginning and an end, which we call birth and death. When born, the living creature feeds on material from outside, which we call food; it increases in size, or grows for a longer or shorter space of time. Afterwards it ceases to grow, it begins to decay, it finally dies. But life is continued by certain small portions of the creature becoming separate from it, and beginning life for themselves. So there is a continuous succession of living creatures kept up; the animal creation is constantly being reproduced. It is not necessary for every animal and plant thus to give rise to new ones: many human beings, as well as other creatures, die without leaving offspring; still a sufficient number leave representatives behind them to keep up the series.

Characters of living creatures.

Cycle of changes; growth, death.

Reproduction.

DISTINCTIONS BETWEEN ANIMALS AND PLANTS.

In common life, and before receiving any special instruction, no one finds a difficulty in distinguishing between animals and plants. Contrast the dog, cat, or horse with the oak. The former can run about, can see, hear, and make sounds; the oak, on the contrary, is quite passive as to all these things. The animal gets and swallows food from without, guided by sight, hearing, and taste; he can attack other animals or defend himself against their onset by means of his limbs; the oak can fulfil none of these functions.

These facts supply us with some first-rate distinctions between animals and plants, and give us also the means of showing what characters are not essential to animals. The animal takes into itself solid food; the oak does not. Many small animals appear to feed on liquids; but it will be found that

Solid food.

these contain minute solid particles which really form their food. For example, an oyster merely has sea-water continually passing through its nearly-closed shell; it has the means, however, of picking out and swallowing the portions of suitable food contained in the water. This test will help us to include various creatures in the animal kingdom when we find out that their food is solid. The sponges, for instance, have currents of water entering and leaving their bodies as regularly as in the case of the oyster; and by careful examination it is proved that they feed similarly by taking in the solid food that floats in the water.

Most of the other features which we named as contrasts between the dog and the oak would fail us somewhere or other in the animal kingdom. Many animals, including the sponges and corals, never move from their position in adult life, although the original creature which founded the organism as we know it, was able to travel for some time. And some undoubted plants are capable of locomotion.

Insufficient distinctions.

Locomotion.

Again, while many animals have distinct and wonderfully constructed eyes and ears, those which do not possess them are also very numerous. Some plants, moreover, show a remarkable sensitiveness to touch, if not to light and sound, and so have a similarity to the highest classes of animals. And just as there are animals that can wound and injure their enemies, so there are plants which can sting and prick or poison those who would do them harm. Thus we may have some idea of the difficulty there is in arriving at a satisfactory division between animals and plants, although it can only be properly understood by making personal acquaintance with the creatures that occasion this trouble. Every endeavour, however, of this kind is the means of adding to our knowledge, of enlarging our ideas and instructing our higher nature, which is the valuable end of study. Let us firmly seat in our minds the broad distinction belonging to animals, that they take food into their interior, and we shall possess the best practical guide to determining what creatures should be reckoned in the animal kingdom. We may add that the food of animals is usually derived either from other animals or from plants, and then refer for fuller details to the lessons on Animal Physiology which will appear in later numbers of the UNIVERSAL INSTRUCTOR.

Organs of sense.

Organs of offence.

IDEAS OF CLASSIFICATION.

The observation of every child reveals to him many different animals with strongly marked characters, and leads him to ponder on the mystery of their diversity and on the reasons for their actions. Too often he pulls to pieces, or cuts up, as many as he can get hold of, being naturally ignorant of any rights that they may have, and purely guided by an instinctive thirst for knowledge. We can easily renew the first rough grouping of childhood, which knows animals by their legs, their teeth, their horns, their wings, their tails. Thus we find around us animals with two pairs of limbs, by which they can walk, run, jump, or climb, such as cats, horses, dogs, frogs. Others are distinguished by the possession of but two legs, combined with a pair of wings for flight—comprehensively denoted as *birds;* and we suppose few have ever failed to distinguish between these and butterflies and bees, which have six tiny legs and four slender wings.

Superficial differences of animals.

Spiders, again, will form a very noticeable group in childhood's observation, but perhaps it is not always set among their peculiarities that they have eight legs, while beetles have only six. The earthworm is another creature that always attracts attention by its sinuous motion and the series of rings it exhibits; while the snail is made familiar to every one by the oft-repeated operation of making it "draw in its horns." Here is a creature slowly gliding along, carrying its house on its back.

Legs: wings: locomotion: shells.

Animals living in water are all popularly denoted as "fish"; yet not all of them even breathe by means of water, and the differences between them are very manifest. The lobster and crab, with their long legs and claws, and their hard external covering, strike us at once as being of a different nature from the soft scaly mackerel or herring, with their peculiar flat fins. Sharply contrasted with both these are the animals that live inside shells, whether composed of one piece, as in the whelk and periwinkle, or of two portions, as in the oyster and scallop. Besides these, the inland boy or girl will have found soft-bodied worms and leeches in fresh water; while the little seaside observer has open to him richer treasures cast up by the sea—the cuttle-fish, with its numerous arms clothed with strong suckers—the star-fish, with its five rough arms extended, forming most of its body—the sea-urchin, with its hard dome covered with spines—the soft mass of the jelly-fish drying up almost to nothing on the strand in the sun of a summer's day. And besides all these, the sponge and the coral are distributed almost everywhere, as the evidences of life that has been, far away.

Aquatic animals.

With no aid but our natural powers of observation we can discern the striking features of these various members of the animal creation. But the microscope further reveals to us a world of life which we could not otherwise see in fresh and salt water, and on the surface of larger animals. Fortified with magnifying lenses, we perceive some small creatures stationary in water, others capable of rapid motion; many with weapons of offence and defence. Some of these appear as complex in their nature as the largest animals, while others are so simple as to astonish us. We thus learn more and more of the variety of the animal kingdom, and the minute compass of space within which the essentials of life can go on.

Life revealed by microscope.

As our faculties ripen, and our reading and observation enlarge, we notice differences

among those creatures which belong to the same great group. We find that the group "four-footed animals" contains some which suckle their young, and others which do not. Among the former, a grouping according to the possession of claws or of hoofs is early learnt. Frequently we find that animals which have hoofs also possess horns. So again we learn to distinguish between birds of different colours, and with varying forms of beak and wing; and we get a practical appreciation—though it may be a very hazy one—of what constitutes the same *kind* of animal in nature.

Distinctions in smaller groups.

We read in books of travel or of natural history about animals with different names, and contrasting in appearance with those we see about us. In menageries some of these are brought in captivity to astonish and interest us, and while we perceive resemblances between some of them and those which are more familiar to us, we find that there are others very distinct from any that live in our neighbourhood. And as we learn the countries or districts from which the strangers are brought, we have it impressed upon us that animals are not similarly distributed over the surface of the globe; and that while man himself, the highest animal, is different in nature and appearance according to the part of the world he comes from, there are much more surprising changes in the forms of animals to be met with in our travels. We hear of a continent like Australia, in which there are no native cows or cats, and where some animals having four legs sit upright upon two of them, supported by a long and strong tail. We are told of the existence of birds taller than ourselves, of butterflies and birds of more gorgeous colours than any we are familiar with. Parrots, monkeys, whales, rattlesnakes, turtles, alligators—such are some of the most diverse groups of whose existence we are informed through the skins of captured animals, by seeing the creatures themselves in captivity, and by the descriptions of naturalists and travellers.

Differences of foreign animals.

XXVII.

The Emperor Charles V.'s Successors and the Thirty Years' War.

The second half of the sixteenth century, a time of warfare and strife in western Europe generally, was a period of exceptional prosperity for the German empire. Ferdinand I., the brother and successor of Charles V. in Germany, was a mild and judicious ruler, anxious to mete out equal justice to all his subjects; and during his reign Protestantism spread exceedingly; so that even in the hereditary dominions of Austria the number of adherents of the Reformed Church greatly increased. The commercial prosperity of the land also advanced rapidly. The great cities, such as Nuremberg, Augsburg, Frankfort-on-the-Main, and the trading communities generally, advanced in wealth and importance. The successor of Ferdinand, his son Maximilian II., a just and far-seeing prince, pursued a policy of complete toleration with regard to his Protestant subjects; so careful, indeed, was he of their privileges, that he incurred the hatred and malevolence of bigots and zealots, who declared that he himself was a concealed Protestant. Under these favourable auspices, the Reformation gained many followers in Hungary, Siebenbürgen, Steyermark, and Carinthia. In Bohemia also, the country where a century and a half before the followers of Huss, the Utraquists and Calixtines, had contended for the administration of the cup to the laity, the reformed doctrines also took deep root, and spread widely throughout the land. Maximilian gave complete freedom of conscience to all his subjects; and Protestant churches were built throughout his dominions. Prosperous and strong, the empire was not only able under his rule to put a speedy end to the internal quarrels among the princes, but also to maintain itself against the Turks, who, after the death of Solyman the Magnificent, were long unable to renew their attacks. But the fair prospects of the Reformation were clouded, and its development was checked, and its influence weakened, by quarrels among the Protestants themselves.

Germany under the successors of Charles V.: Ferdinand I., A.D. 1556–1564.

Prosperity and progress.

Melanchthon, always anxious to promote peace, had softened various doctrines of the Lutheran faith, in the hope of including the various branches of the Protestant Church in a general union. The result was a division of the Lutherans into two sections: the orthodox party, who strictly followed Luther, and whose tower of strength was the university of Jena; and the Philipists or Crypto-Calvinists, the followers of Melanchthon, who maintained their position at Wittenberg, the birthplace of the Reformation. After Melanchthon's death, when this great peacemaker's voice was withdrawn, the strife between the sects raged fiercely. The Protestant house was thoroughly divided against itself; and the frank fearless spirit of the Reformation was lost in the jangling strife of angry theologians. Political jealousies among the Protestant princes, the revival of the old quarrel between the Albertine and Ernestine lines in Saxony, and the envy with which the Saxon elector Augustus looked on the increasing influence of the Count Palatine Frederick, who had been converted to Protestantism, embittered the division between the strict Lutherans and the Adiaphorists, who looked upon many ceremonies and outward forms as non-essential. The Lutherans also, while they quarrelled with the Philipists, utterly repudiated all association with the Calvinists. While the Protestant Church was thus split up into factions, the Jesuits made

Religious discussion.

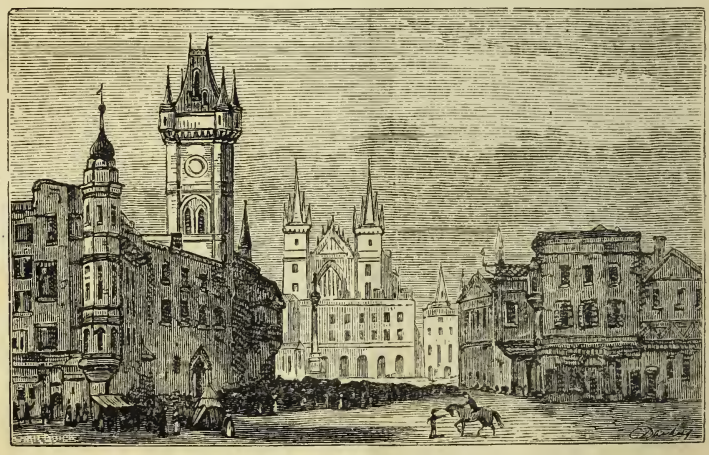
the most of the opportunity afforded by their opponents' disunion. They represented Protestantism as an accursed thing, the herald of confusion and rebellion; and standing firmly together, under excellent discipline, they brought back many waverers into the Catholic camp. Maximilian II. was himself partly inclined to the reformed faith; but alarmed at the quarrels of the Protestants, he hesitated to fulfil the expectations entertained by the Lutherans that he would openly join their party. Ambitious hopes, moreover, concurred to keep him in the Catholic communion. The death of Don Carlos, the unhappy son of Philip II., opened to Maximilian the tempting prospect of the succession to the crown of Spain; and that a Protestant prince should sit on the Spanish throne he saw was impossible. To the ambition for extended rule which for centuries formed the leading characteristic of the princes of the Hapsburg line, he sacrificed the unity of the

Influence of the Jesuits.

Maximilian II., 1564–1576.

demands on the part of Catholics for the restitution of secularized Church property. Rudolf, occupied with alchymy, astrology, and the management of his stables in Prague, remained unconcerned and indifferent while the storm gathered around him. His provinces revolted, and his brother Matthias, assisted by various members of his house, forced the weak emperor to yield up successively the Austrian duchy Hungary and Moravia. Rudolf granted to Bohemia a charter or Letter of Majesty, giving extended rights of self-government to his Bohemian subjects, who were nearly all Protestants. But this did not prevent the loss of that kingdom; and at length Rudolf was as powerless as any sluggard king among the Merovingians of old. And now the reaction assumed a bolder front. Gebhard, archbishop of Cologne, was driven from his territories for adopting the Protestant faith; and the Catholic Bavarian Ernest was installed in his stead. The Lutherans foolishly refused

Bohemia: The "Letter of Majesty."



IN THE CITY OF PRAGUE.

German empire and the prospects of national and religious progress. He adopted the policy of Charles V., who always subordinated the interests of the empire to the increase of his own hereditary power.

Under the successor of Maximilian, the weak and slothful Rudolf II., the reaction against the Reformation attained far wider proportions. The Jesuits were more active than ever in fanning the flame of religious strife. They gained a great point when they contrived to unite against German Protestantism the two branches of the Hapsburg family, long at enmity with each other. They had two useful disciples and tools in the Archduke Ferdinand of Steyermark, a grandson of Ferdinand I., and the Duke Maximilian of Bavaria. Both these princes looked upon Protestantism as a heresy to be rooted out by any and every means. Soon the empire was filled with complaints of arbitrary disregard of the religious peace, and of unjust

Rudolf II., 1576–1612.

assistance to Gebhard, on account of his Calvinistic tendencies; and soon after Bonn, Neuss, and various other Protestant towns, were forced to submit to the Counter-reformation. Donauwörth, an imperial city, was deprived by Maximilian of religious freedom for having interrupted a procession. Ferdinand, the archduke, introduced compulsory uniformity of faith and worship into his territories, burnt the Bibles and pulled down the churches and schoolhouses of Protestant communities, and expelled from the country all who refused to attend mass. At Bonn, after the besieged town had submitted to the Bavarians, the chief clergyman of the Reformed Church was bound hand and foot and cast into the Rhine. From Aix-la-Chapelle the Protestant magistrate and the evangelical clergy were forcibly expelled. Throughout the length and breadth of Germany the Counter-reformation was in full activity.

Ferdinand of Grätz. His intolerance.

At length the oppressed Protestants found a

champion in the Elector Palatine Frederick IV., who, in conjunction with Christian of Anhalt, succeeded in forming various Calvinistic and Lutheran states, and fifteen imperial cities, into a Protestant Union, for the joint defence of religious rights and privileges. This step was met by the formation of the Catholic League by Maximilian of Bavaria, who allied himself with the Catholic bishops of Treves, Mayence, and Cologne, and with those of Salzburg, Ratisbon, Augsburg, etc., in opposition to the confederated Protestants. The death of Henry IV. of France, upon whose aid the Protestant Union reckoned in a projected war, deferred the outbreak of hostilities for some years. It is curious that, as in the war of the Smalcaldic League the Protestant and Catholic factions had been led by the rival princes of the Saxon house, so now the Union and the League were respectively organized under the leadership of two branches of the house of Wittelsbach.

The Elector Palatine IV. and the Protestant Union.

Of Henry IV. of France and of his death by the hands of the fanatic Ravaillac, we have already spoken (*see* vol. i. p. 695). His life had been attempted no fewer than nineteen times previously, and most of these attempts had been traced to the agency of the papal and imperial courts. The murderer, we have good evidence for believing, was a mere tool in the hands of the Jesuites, Henry's implacable foes, notwithstanding the many concessions which he made to their order.

CANAL IN GHENT.

FRENCH GRAMMAR.

XXI.

THE ADJECTIVE (*continued*).—THEORY.

1. SOME HINTS ON THE USE OF THE DEGREES OF SIGNIFICATION IN ADJECTIVES.

a. When the first of a series of adjectives is compared, the others are likewise compared, be they used as comparatives or superlatives: Julia is taller and handsomer than Mary, and Mary is more contented and happy than Julia = *Julie est* PLUS *grande et* PLUS *belle que Marie, et Marie est* PLUS *contente et* PLUS *heureuse que Julie;* Lucy is the handsomest and cleverest of our pupils = *Lucile est* LA PLUS *belle et* LA PLUS *intelligente* (or *spirituelle*) *de nos élèves;* Harriet is the least contented and happy of the schoolgirls = *Henriette est* LA MOINS *contente et* LA MOINS *heureuse des écolières;* John is very naughty and stubborn = Jean est TRÈS méchant *et* TRÈS *entêté.*

b. Comparatives and superlatives, as the above examples show, may be used both as predicates and attributes. When they are used as attributes, however, the French language presents no distinction between, *e.g.*, the *brighter* ribbon (of two) and the *brightest* ribbon (of more than two); both degrees are rendered by *le ruban le plus brillant*, whether

one adds *des deux rubans* or *de tous les rubans.* So, Of two evils he chose the lesser = *de deux maux il choisit le moindre.* A brighter ribbon, of course, would be rendered by *un ruban plus brillant;* and a lesser evil by *un moindre mal.*

c. The preposition which introduces the adverbial phrase modifying the adjective compared is *de*, in French, whatever the corresponding preposition may be in English: the best tailor in London = *le meilleur tailleur* DE *Londres;* the best cobbler in the village = *le meilleur savetier* DU (for *de le*) *village;* the worst thing in the world = *la pire chose* DU *monde;* Calypso was taller than her nymphs by a whole head = *Calypso était plus grande que ses nymphes* DE *toute la tête.* An inversion in the construction would leave the rule unaltered; *l'invention du monde la plus heureuse* (Voltaire); *par le caprice du monde le plus bizarre* (Boileau). If we say, there is no better woman in the world, *in the world* no longer modifies the adjective, and the translation would be *il n'y a meilleure femme au monde* (or *dans le monde*); the phrase is elliptical, standing for *il n'y a pas au monde de femme qui soit meilleure.*

d. As *better, worse*, and *less* (likewise *best, worst* and *least*) form severally the comparatives and superlatives of both an adjective and adverb, it will prove useful to study the following scheme well:—

		COMPARATIVE.		SUPERLATIVE.
ADJ. good, *bon* / ADV. well, *bien*	better	*meilleur* / *mieux*	best	*le meilleur* / *le mieux*
ADJ. bad, *mauvais* / ADV. badly, *mal*	worse	*pire* / *pis*	worst	*le pire* / *le pis*
ADJ. small, *petit* / ADV. few, little, *peu*	less	*moindre* / *moins*	least	*le moindre* / *le moins.*

As a help to memory, let it be observed that the adverb always presents the shorter form.

**e.* It was stated in last lesson (see vol. i. p. 705) that *plus petit, le plus petit* may be used instead of *moindre, le moindre*, for the degrees of signification of *petit*, but these forms cannot be used indiscriminately. Whereas *plus petit* and *le plus petit* refer to *volume* and *extent* only, *moindre, le moindre* refer to *volume, extent, quantity*, and *quality:* Comme c'est dans *les plus petits* vases que l'on enferme les essences les plus exquises, il semble que la nature se plaise à mettre dans *les plus petits* corps les âmes les plus précieuses (Voltaire). Compare with this the following: Cette colonne est moindre (*or* plus petite) que l'autre en grosseur *(volume)*; La distance est moindre (*or* plus petite) que je ne croyais (*extent*); Ma douleur n'est pas moindre que la vôtre *(quantity)*; il tient un moindre rang que vous (*quality*). Instead of *pire, le pire, pis, le pis*, the forms *plus mauvais, plus mal*, etc., are met with; but this only occurs rarely. However, it must be observed that the prevailing custom is—with the exception of *être* and the phrase *pis aller*—to employ *plus mal* to modify verbs that obtain no objects: *il a agi plus mal que vous.* In old French *il a agi pis que vous* would not have been reckoned as faulty.

f. Aîné, elder, eldest (from *ains* = *ante*, before, and *né* = *natus*, born); *cadet*, younger, youngest (from O.F. *capdet* = *capitettus*, a romance diminutive of *caput*, head); *puiné*, younger, but never youngest (from *puis*, after, and *né*, born); these three present comparative and superlative ideas, and cannot be further compared.

* Paragraphs in small print are not intended for beginners.

2. PRELIMINARY NOTIONS CONCERNING THE VERB (*continued*).—Construction of the Interrogative phrase.

a. There are two ways of asking a question in French. The first, and by far the more popular, is formed by the phrase *est-ce que* (or *est-ce qu'* before a vowel or mute *h*), which means *is it that, is it indeed a fact that . . . .?* [It has lost its original emphasis, and is preferred to any other form by the less educated, because it admits, in spite of appearances, of a simpler construction; after *est-ce que* the proposition always presenting itself in what is called the natural order: viz., 1, *subject* or *nominative*, 2, *copula* or *verb*, 3, predicate.] Examples:

Est-ce que le fils reviendra? *Will the son return?* (Subject, a noun.)
Est-ce qu'il reviendra demain? *Will he return tomorrow?* (Subject, a personal pronoun.)
Est-ce que le mien reviendra? *Will mine return also?* (Subject, a possessive pronoun.)
Est-ce que celui-ci reviendra tout seul? *Will this one return quite alone?* (Subject, a demonstrative pronoun.)
Est-ce que quelques-uns reviendront de la guerre? *Will some (of them) return from the war?* (Subject, an indefinite pronoun.)

b. The other way consists in placing the subject, but only in the case of its being a personal pronoun, after the verb, and joining it to the verb by a hyphen: *reviendra-t-il?* will he return? *est-il revenu?* has he returned? Should the 1st person sing. be a monosyllable, the first form of asking would alone be admissible; it would, for instance, be a fault to say *prends-je?* do I take? *pends-je?* do I hang? *est-ce que je prends? est-ce que je pends?* alone can be used. Usage has, however, sanctioned *ai-je?* have I? *dis-je?* do I say? *dois-je?* must I? *fais-je?* do I make? *puis-je?* can I? *sais-je?* do I know? *suis-je?* am I? *vais-je?* do I go? *vois-je?* do I see? When the 1st person sing. ends with an *e* mute, this is changed into a close *e* by the acute accent being placed over it: *aimé-je?* do I love? If this were omitted, there would appear in *aime-je* two successive mute syllables, as *e* in *je* becomes mute when that pronoun is carried after the verb: *aim'-je'* or *cherch'-je'* (do I seek?) would present a very harsh sound, which is avoided in *aimé-je', cherché-je'*. The student's ear will soon guide him to avoid even *cherché-je'* and substitute *est-ce que je cherche* for it. The simpler interrogative construction would likewise be avoided in the 1st person when the last syllable is nasal: one does not say *réponds-je?*—do I answer? but *est-ce que je réponds?* In poetry *est-ce que*, owing to its clumsiness, is avoided as much as possible.

c. When the subject is a noun, or a possessive, demonstrative, or indefinite pronoun, the form *est-ce que* not being desired, the noun is placed *before* the verb, and a personal pronoun, referring back to the subject, is placed *after* the verb and joined to it by a hyphen. Examples:

La fille reviendra-t*-elle? *will the daughter return?*
La mienne reviendra-t-elle? *will mine return?*
Celle-ci reviendra-t-elle? *will this one return?*
Quelques-unes reviendront-elles? *will some (of them) return.*

** The use and origin of the euphonic *t* have been already explained (see vol. i., page 75 *a*).

Practical Application..

(1) VOCABULARY XII.

(*Nouns offering one sense in the singular and another in the plural, although most of them are also used in the plural with the sense attached to the singular.*)

	IN THE SINGULAR.	IN THE PLURAL.
un aboi	*dog's bark*	*extremities*
une aide	*assistance*	*subsidies*
une arme	*weapon*	*crest, coat of arms*
un arrêt	*verdict*	*arrest, prison*
le ciseau	*chisel*	*scissors*
la défense	*defence*	*tusks*
un échec	*failure*	*chess*
un effet	*effect*	*bills*
une épingle	*pin*	*pin-money*
un état	*state*	*the orders (in the State)*
le faste	*pomp*	*annals*
le fer	*iron, sword*	*chains, fetters*
la force	*strength*	*troops*
la franchise	*frankness*	*immunities*
le gage	*pledge*	*wages, salary*
la harde	*herd (of deer, etc.)*	*clothes*
une heure	*hour*	*Horæ, prayer-book*
un honneur	*honour*	*dignities*
la lettre	*letter*	*literature*
la lumière	*light*	*knowledge*
la lunette	*telescope*	*spectacles*
la menotte	*child's hand*	*handcuffs*
la mouchette	*tringle, moulding plane*	*snuffers*
le neveu	*nephew*	*descendants*
une ouïe	*hearing*	*gills*
la pâque	*Jewish feast*	*Christian Easter*
la pratique	*practice*	*outward devotions, intrigues*
la tablette	*shelf*	*pocket-book*
la tranchée	*trench*	*gripes*
la troupe	*band*	*troops*
la vacance	*vacancy*	*holidays*
la veille	*eve, watch*	*night work*
le vêpre*	*evening*	*evensong (f.)*

(2) First part of the conjugation of *Finir:* model for verbs ending in *ir*.

INFINITIVE.

PRESENT, finIR, *to finish.* PAST, avoir finI, *to have finished.*

PARTICIPLE.

PRESENT, finISSANT, *finishing.* PAST, finI, *finished*; ayant finI, *having finished.*

INDICATIVE.

Simple Tenses.		*Compound Tenses.*	
PRESENT.		PERFECT INDEFINITE.	
je finIS	*I finish, etc.*	j'ai fini	*I have finished, etc.*
tu finIS		tu as fini	
il finIT		il a fini	
nous finISSONS		nous avons fini	
vous finISSEZ		vous avez fini	
ils finISSENT		ils ont fini	
IMPERFECT.		PLUPERFECT.	
je finISSAIS	*I was finishing, etc.*	j'avais fini	*I had finished, etc.*
tu finISSAIS		tu avais fini	
il finISSAIT		il avait fini	
vous finISSIONS		nous avions fini	
vous finISSIEZ		vous aviez fini	
ils finISSAIENT		ils avaient fini	

* *Vêpre* is no longer used in that sense; although Molière uses it, he places it in the mouth of an old-fashioned character: "*Je donne le bon vêpre à toute l'honorable compagnie.*" (Comt. d'Esc. 17.)

PERFECT DEFINITE.		PERFECT ANTERIOR.	
je finIS	*I finished, etc.*	j'eus fini	*I had finished, etc.*
tu finIS		tu eus fini	
il finIT		il eut fini	
nous finîMES		nous eûmes fini	
vous finîTES		vous eûtes fini	
ils finIRENT		ils eurent fini	
FUTURE ABSOLUTE.		FUTURE ANTERIOR.	
je finIRAI	*I shall finish, etc.*	j'aurai fini	*I shall have finished, etc.*
tu finIRAS		tu auras fini	
il finIRA		il aura fini	
nous finIRONS		nous aurons fini	
vous finIREZ		vous aurez fini	
ils finIRONT		ils auront fini	

(3) The personal pronouns used as direct objects (accusatives) to a verb are *me*, me; *te*, thee; *le*, him or it; *la*, her or it; *nous*, us; *vous*, you; *les*, them for both genders. They are all placed before the verb, whether the proposition is affirmative, negative, or interrogative: *je* LE *finis*=I finish it; *nous ne* LES *finissons pas*=we do not finish them; LES *aplatissez-vous*=do you flatten them? When the verb before which *me*, *te*, *le*, and *la* are to be placed begins with a vowel or *h* mute, these pronouns suffer elision: *je l'aplatis*=I flatten it; *il m'aime*=he loves me, etc.

(4) Verbs conjugated like Fin*ir*: bann*ir*, to banish: brand*ir*, to brandish: éblou*ir*, to dazzle: franch*ir*, to cross: gém*ir*, to groan: gross*ir*, to enlarge: guér*ir*, to cure: pér*ir*, to perish: pun*ir*, to punish: réuss*ir*, to succeed: sais*ir*, to seize: tern*ir*, to tarnish: trah*ir*, to betray: un*ir*, to unite.

EXERCISE XXXIII.

1. She will finish; she finished; she was finishing; do we finish? 2. I punish you; you will punish me; thou wast punishing them; *didst* (hast) thou punish(ed) him? 3. He seizes a weapon and crosses the trench; does he seize a weapon and *cross* (does he cross) the trench? 4. You dazzle me with your coat of arms and (your) motto (*devise*). 5. The light dazzles them; does the light dazzle them? 6. Literature and knowledge will perish; will literature and knowledge perish? 7. Our descendants will groan; why (*pourquoi*) will they groan? 8. His two nephews have perished in (*à la*) China. 9. My telescope enlarges objects very much (*beaucoup les objets*); does your telescope enlarge objects very much? 10. You tarnish my spectacles; you do not tarnish them; do you tarnish them? 11. They groan in (*dans les*) fetters. 12. He was brandishing his sword; you were brandishing them. 13. They seized him on (*à*) the eve of the holidays. 14. Frankness does not banish good-breeding (*le savoir-vivre*). 15. Does Prospero punish Caliban? was he punishing him? 16. My poor boy, the eldest daughter will have dazzled thee by her knowledge, and the youngest *one* by her charms (*ses charmes*). 17. They will not succeed in preserving their (*à préserver leurs*) immunities. 18. Pomp and dignities have succeeded in (*à requires the infinitive*) curing him. 19. His younger brother betrayed his country (*sa patrie*) and perished on the scaffold (sur l'échafaud). 20. Do I unite? was I uniting? shall I unite? *did I unite* (have I united)?

BY THOMAS DUNMAN.

I.

Frictional Electricity.

One of the most important and interesting branches of physical science is undoubtedly that of Electricity—a science which has shared, perhaps, more than any other in that great advance in general scientific knowledge which the present century has seen. It is, moreover, a science which will no doubt specially commend itself to our readers, inasmuch as it is one which may be experimentally studied with apparatus, in general, of the most simple and inexpensive kind; and there are but few, even of its more elaborate experiments, which may not be performed by the intelligent student at a moderate outlay of money, if only that outlay be coupled with the expenditure of a little patience, tact, and ingenuity.

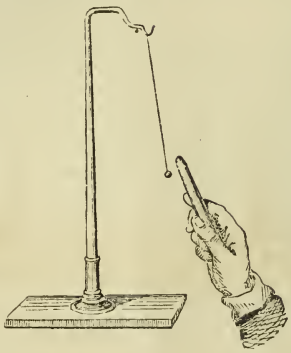


FIG. 1.—AN ELECTRIC PENDULUM.

One of the great advantages of a study of natural science, beyond the important fact that it gives us a more comprehensive view of the phenomena of nature than we should otherwise possess, is that it brings into play that faculty of personal observation which is too often allowed to lie dormant, and which no other branch of study calls forth in anything like an equal degree. In such studies as those of history or grammar, we are necessarily taught to accept facts upon authority, and from that authority there can be no appeal; but the student of physical science is taught to verify, as far as possible, for himself every fact which is brought before him by actual experiment, to test it by the evidence of his own senses, to know it of his own knowledge. In this spirit we intend conducting our readers through the interesting and pre-eminently experimental science of electricity; and, as we shall give full instructions for the performance of experiments and for the construction of the necessary apparatus, we sincerely trust that our students will not rest satisfied with merely reading the accounts of the facts and phenomena which it will be our duty to describe, but will endeavour to verify them for themselves by performing at least the more simple of the experiments by which they may be illustrated.

Advantages of a study of electricity.

FIG. 2.—ELECTRIC EEL. (*Gymnotus electricus*).

For our first lesson the apparatus necessary is of such of a simple character, that it may be found ready to hand in almost every household. A few pieces of brown paper, a lath, a stick of sealing-wax, a piece of glass rod, a sheet of foreign letter paper, a clothes-brush, a piece of flannel, a piece of silk, and a piece of india-rubber,—these are the only materials with which we must be furnished in order to commence our studies in frictional electricity.

The necessary materials.

Supplied with these simple requisites, let us see how by a judicious use of them we may learn a few fundamental facts of interest and importance. Before we begin, however, it will be necessary to assure ourselves that our materials are quite dry and clean; and it will be as well to state, once for all, that in all our electrical experiments it will be necessary to have our apparatus perfectly dry (in most cases even warm), and perfectly clean, if we would ensure success. We must remember that experiment is the language by which we question nature, and we have no more right to address her in slipshod and careless terms than we have to employ uncouth and ungrammatical speech in our conversation with those around us. Nature, rightly named of the feminine gender, is a somewhat exacting and fickle goddess; and if we would get from her certain and unequivocal replies, we must address to her equally clear and unmistakeable questions. Those questions are our experiments, and it is therefore essential that we should perform them carefully and neatly, never being satisfied with just making a thing *do*, but continuing our efforts until we have attained complete success.

Necessity for having apparatus perfectly dry and clean.

Being then assured that our materials are in proper condition, let us proceed to make use of them. First it will be necessary to balance the lath in such a manner that it will turn readily upon its centre. The best way to do this is to get an egg, put it with its narrow end upwards in an egg-cup, and carefully balance the lath upon it. Another plan is to take a Florence oil flask, and place it neck downwards in an empty bottle, and then balance the lath upon the bottom of the flask. Having in either of these ways balanced your lath, now rub your stick of sealing-wax briskly with a

Preliminary experiments.

piece of warm flannel, and bring it near one end of the lath; the lath will be attracted towards it, and if you are careful you will succeed in making the lath follow the sealing-wax, so as to perform a complete rotation upon its centre.

Bring your excited stick of sealing-wax near some small scraps of paper, feathers or any light substances, and they will be attracted to it.

Now take your glass rod, warm and rub it with warm silk, and bring it near the lath; and, as with the sealing-wax, the lath will be attracted. Any light materials will also be drawn towards the excited glass, as they were towards the excited wax.

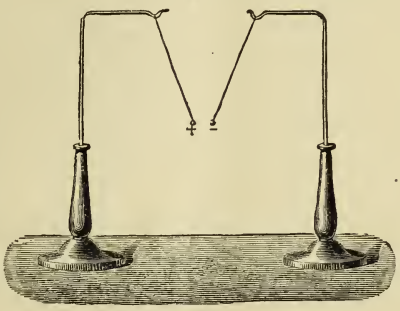


FIG. 3.—ELECTRICAL-PENDULUM EXPERIMENT.

In just the same manner warm brown paper rubbed with a clothes-brush, or even with the hand, and foreign post paper rubbed with india-rubber, will be found to exhibit this power of attracting light substances which are free to move.

Other simple experiments.

A very amusing experiment with the excited brown paper is to hold it over the head of a person whose hair has not received too liberal an allowance of pomade; when it will be seen to attract towards it the individual hairs, which will literally "stand on end, like quills upon the fretful porcupine."

If either the excited brown paper, or the foreign paper rubbed briskly with india-rubber, be held near a wall and let go, they will fly to it, and stick there for some minutes before falling.

These are but a few of the instances of simple attraction which we may obtain from our materials, and we might have obtained similar results with other equally simple substances. Enough, however, has been seen to show the truth of our first statement of fact—which is, that *certain substances, such as sealing-wax rubbed with flannel, and glass rubbed with silk, have the power of attracting light bodies.*

The facts arrived at by the above experiments.

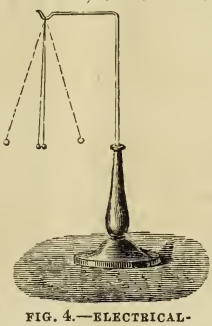


FIG. 4.—ELECTRICAL-PENDULUM EXPERIMENT.

More than two thousand years ago it was known to the Greeks that amber when rubbed with a woollen cloth had this mysterious power conferred upon it, and the Greek word for amber being *elektron*, substances when they possess this power are said to be *electrified;* while to this power of attracting light bodies, exhibited by amber and other substances when excited, the term *electricity* has been given; moreover, as this electricity is produced by friction, it is, to distinguish it from electricity produced in other ways, termed *frictional electricity.*

Origin of the word electricity.

For more than two thousand years the discovery that amber rubbed with cloth attracts light bodies remained an isolated fact, until in the year 1600 Dr. Gilbert of Colchester, physician to Queen Elizabeth, showed that the power thus conferred upon amber by friction might also in the same way be conferred upon other bodies, such as sulphur, glass, and sealing-wax; and it is to Dr. Gilbert that we are indebted for the term *electricity.*

Early progress of the science.

One of the earliest results of electrical research was to show that all substances are not alike with regard to their power of exhibiting electrical excitement, and it was at one time thought that some substances, such as the metals, could not under any circumstances be electrified.

All substances not electrically the same.

If, for instance, we substitute in our previous experiments a metal rod for the sealing-wax or glass, we shall find that no amount of rubbing will produce in it the least electrical excitement, so long as it is held in the unprotected hand. This fact gave rise originally to a classification of substances into two groups, one comprising those which exhibit electrical excitement when held in the hand and rubbed, and which were termed *electrics*, and the other comprising those which under similar conditions did not exhibit electricity, and which were accordingly termed *non-electrics.* This classification has, however, been shown to be erroneous, for if we hold a metal rod, one end of which is surrounded by vulcanized india-rubber, in the hand, we shall find that by rubbing the other end we can electrify it in the same way as we can glass or sealing-wax.

Electrics and non-electrics.

The true explanation of this curious fact is that bodies differ from each other in the rapidity with which the electricity generated upon them by rubbing passes from the part rubbed to the other parts, and so from them to other bodies with which those parts are in contact. In some bodies, as the metals, the electricity generated rapidly diffuses itself over the whole mass of the electrified body, and passes away to surrounding bodies, while in others—as wax or glass—this diffusion is extremely slow. The former condition is expressed by saying that the body is a good *conductor;* the other by saying that the substance is a *non-conductor.* It must, however, be clearly understood that there is no such thing as an *absolute* non-conductor; *all* substances conduct electricity more or less rapidly, and when we speak of a *conductor* we signify a substance possessing this power in a very high degree,

Conductors and non-conductors.

while by a *non-conductor* we signify a substance which conducts very feebly.

With this qualification we shall, in accordance with common usage, employ the terms conductor and non-conductor; and the following list of substances, arranged in the order of their conductivity, the best conductors being placed at the top and the worst at the bottom, will be found useful :—

Relative conductivities of various bodies.

Metals.	Metallic Oxides.
Gas Coke.	Ice at —25°C.
Graphite.	Fats and Oils.
Solutions of Hydrogen Salts.	Caoutchouc.
Solutions of Metallic Salts.	Gutta Percha.
Metallic Sulphides.	Dry Air, Gases, and Vapours.
Water.	Wool.
Metallic Salts (solid).	Ebonite.
Linen.	Diamond.
Cotton.	Silk.
Hemp.	Glass.
Paper.	Wax.
Alcohol.	Sulphur.
Ether.	Resins.
Dry Wood.	Amber.
Dry Ice.	Shell-lac.
	Paraffin.

From this list it will be seen that the metals are the best conductors, and that paraffin is the worst. It will also be noticed that water occupies a high position in the list, and is therefore a good conductor of electricity. This will explain the necessity for having all our electrical apparatus perfectly dry—for, if it be damp, the moisture conducts away the electricity as fast as it is generated, and little or no electrical excitement is rendered apparent.

Substances which are non-conductors are often useful to prevent the escape of electricity from a good conductor, and this is the philosophy of electrifying a metal rod by holding it in a sheet of vulcanized india-rubber or caoutchouc, which our list shows us is a fairly good non-conductor. Thus held, the metal rod when rubbed becomes electrified, and the electricity generated cannot escape from the rod into the hand, because of the non-conducting caoutchouc which intervenes ; whereas, when the metal is held in the naked hand, the electricity generated by friction at once escapes through the body, which is a good conductor, and therefore none is found upon the rod. When a non-conductor in this way intervenes between an electrified substance and other conducting substances, the electrified body is said to be *insulated*, and the non-conducting material is then termed an *insulator*.

Insulating substances.

Hitherto we have only dealt with instances of the simple attraction of unelectrified substances by those which are electrified ; now we must turn our attention to the action of electrified bodies upon each other.

Action of electrified bodies on each other.

In order that we may do this effectually, it will be necessary to construct our first piece of electrical apparatus, which is represented in fig. 1.

Upon a wooden stand is fixed a glass rod, the extremity of which is drawn out fine and bent into a kind of hook. This is accomplished by holding the glass in the flame of a gas-burner or spirit-lamp until red-hot and soft, when it can be bent to any desired shape. It is best to make the hook at some little distance from the tapering end of the glass rod, and the piece beyond can afterwards be broken off by making a mark first with a triangular file ; the glass rod can be fixed in the stand by resin or glue. To make the glass perfectly non-conducting, it should be coated with a thin layer of shell-lac varnish. From the hook is suspended, by a silk thread dipped in melted paraffin, a pith ball or small feather. This simple piece of apparatus forms what is known as the *electrical pendulum*.

How to make an electrical pendulum.

For those who wish to save time and trouble the stand may be dispensed with, and the silk thread and pith ball suspended directly from a gas-pipe or any other projection. As the shell-lac varnish mentioned above is a very useful material, it may be as well to give here instructions for preparing it :—Get some shell-lac (*orange* shell-lac is the best), just cover it with methylated spirit, and leave it to stand for about twenty-four hours, shaking it occasionally. Then pour off the clear fluid and treat the undissolved lac (if any) with a little more spirit. The varnish is applied in the ordinary way with a brush, and dries immediately.

Shellac varnish.

Having constructed your electrical pendulum, touch the pith ball with an excited glass rod ; it will first be attracted by the rod and then repelled by it ; while, if an excited stick of sealing-wax be brought near the pith ball, the latter will be attracted. In like manner, if the ball be electrified by excited sealing-wax it will afterwards be repelled by sealing-wax and attracted by excited glass. If, moreover, you make two electrical pendulums, and electrify the pith ball of one with excited sealing wax and the pith ball of the other with excited glass, the two pendulums upon being brought near will be powerfully attracted towards each other, while if both pith balls be similarly electrified they will repel each other. Fig. 3 shows us the condition of the pith balls in one case, and fig. 4 their condition in the other.

Experiments with the electrical pendulum.

From these experiments it seems clear that the electricity which is developed on glass by the friction of silk differs from that generated on sealing-wax by rubbing it with flannel. It seems equally clear that each kind of electricity *repels* the *same* kind, but *attracts* the *opposite* kind.

Two kinds of electricity.

By way of summarising the facts with which our first lesson has made us acquainted, we may say :—*Frictional electricity is produced by rubbing certain bodies together ; it is conducted much more readily by some substances than by others; it exists under two forms which are mutually repellent, and which are respectively produced when glass is rubbed with silk and sealing-wax with flannel.*

XXVI.

The Solar System.

THE solar system may be regarded as consisting of a great number of bodies of very different dimensions moving round the sun in elliptical orbits at different distances and at different velocities. Some of these bodies are known to be accompanied by lesser companions, which move round them as they revolve round the sun. These secondary bodies are known as the satellites, and are comparatively few in number.

Planets and satellites.

The most massive of these bodies which revolve round the sun are known as the major planets, and at the present time eight are known. We say at the present time eight are known, because a century ago there were only six supposed to exist, Saturn being thought to be the outermost planet; yet since this two others have been discovered—Uranus beyond Saturn in 1781, and Neptune beyond Uranus in 1846—so it is by no means certain that there are not other planets beyond even Neptune. Indeed, some evidence has been advanced by astronomers for believing that other planets do exist beyond Neptune. As these planets would shine like very faint stars and move very slowly, they could only be detected with great difficulty, so that if they exist many years may elapse before they are discovered. The eight known planets are called Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune. They may be divided into two groups of four each, the four inner planets, Mercury, Venus, Earth, and Mars, being known as the smaller planets, and ranging in diameter from 3000 to 8000 miles; and the four outer or giant planets, Jupiter, Saturn, Uranus, and Neptune, whose diameters range from 30,000 to over 80,000 miles, or ten times as great as those of the four inner planets. These eight planets move round the sun in orbits of the form of ellipses whose eccentricity is so small that, except in the cases of Mercury and Mars, the two smallest of the eight, they are nearly circular. Even in the case of these two exceptions the eccentricity is not large enough to show any marked deviation from a circular form. The orbits of these planets are in all cases only slightly inclined to the plane of the ecliptic or orbit of the earth.

The major planets.

Moving round these planets, in the same manner as the planets move round the sun, are other smaller bodies known as the satellites or planetary moons. At the present moment twenty of these moons are known. One revolves round the earth, two move round Mars, four belong to Jupiter, eight to Saturn, four to Uranus, and one to Neptune. It is very probable that in course of time a number more of these satellites may be discovered, for we know they are very variable in size, and the smaller ones would be very difficult to discover. Thus the two small moons belonging to Mars were only discovered in August 1877, having escaped detection, though they had often been looked for, because they are so small. The greater number of the known moons are of very considerable size. Thus the moons of Jupiter are as large as our own moon, and as big as the smaller planets Mercury and Mars. The two principal satellites of Saturn and of Uranus, and the satellite of Neptune, are probably fully as large as those of Jupiter. Five of the remaining satellites of Saturn and the two smaller satellites of Uranus are much smaller—probably only about one-third of the diameter of our moon, or about one-thirtieth of the bulk. The smallest known satellite of Saturn is probably still smaller—perhaps only one-tenth of the diameter of our moon or one-thousandth of the bulk. Finally, the two recently discovered satellites of Mars are much smaller still—perhaps only one-hundredth of the diameter of our moon, which would make their bulk less than one-millionth. If any of the other planets have satellites as small as those of Mars, it is very unlikely that they will be discovered for a very long time, for they would be so faint that the most powerful telescopes would be required to see them.

Planetary moons.

The next class of bodies moving round the sun are known as the minor planets, or, as they are sometimes called, the asteroids. They form a great group of small planets moving round the sun between the orbits of Mars and Jupiter. The first of these bodies was discovered at the commencement of this century, and up to the present time nearly two hundred have been discovered. These minor planets are all very much smaller than the smallest of the major planets, for the largest of the group is not one-twentieth of the diameter of the earth, and possesses not one-ten-thousandth of its bulk, whilst the smaller ones are probably less than one-fiftieth of the diameter or one-hundred-thousandth of the bulk of the larger ones. It will be seen, therefore, that the smaller of the minor planets are very small bodies indeed—in fact, only five or six miles in diameter. Nevertheless, even these small planets probably have a mass of thousands of millions of tons. These minor planets move round the sun in exactly the same manner as the larger ones, and possess orbits of the same form, though the eccentricity and inclination of these orbits are often very considerable. No satellites have been discovered moving round these minor planets; and this is not surprising, for it would be very difficult to see so small a body as the satellite of a minor planet must necessarily be.

The minor planets.

Of late years indications have been discovered of the existence of a similar belt of small planets, moving round the sun within the orbit of the planet Mercury. On several occasions minute round dark bodies like miniature planets have been seen to cross the sun in a direc-

Intra-Mercurial planets.

tion and at a rate which would indicate that they were intra-Mercurial planets, moving round the sun in orbits about half-way between the sun and Mercury. Lately, likewise, during solar eclipses bright planetary-like objects have been seen near the sun, shining like stars of the 3rd or 4th magnitude, in places believed to be different from the places of any stars of similar brightness. These bodies appear to be considerably smaller than the planet Mercury, perhaps scarcely a third of the diameter of that planet, though slightly larger than the largest of the group of minor planets moving in orbits between those of Mars and Jupiter. There may be many much smaller than these: they have been suspected to exist, and from their close proximity to the sun, it would be very difficult to detect them.

A third class of bodies moving round the sun are distinguished by their enormous number and very minute size. The vast majority of them are much smaller than a cricket-ball, a very small minority may be as large as a foot-ball, and it is possible that there are a very much smaller number still that have a diameter of a few feet. The mass of the largest of these bodies is therefore many million times less than that of the smallest of the minor planets. Many of these minute bodies rush through the atmosphere of the earth, and by the friction against the air become white-hot, so that they can be seen. They are then called *meteors*, and now the name is applied to the whole class. It has been estimated that these meteors are so exceedingly numerous that the earth in its daily motion intercepts more than a thousand, mostly of the smallest dimensions. They move round the sun in elliptical orbits like the planets, but instead of these orbits being very nearly circular, there is reason to believe that many of them move in orbits of great eccentricity—orbits that are very much longer than they are broad. A great number of the meteors move round the sun in great groups, all flying with very nearly the same velocity and in the same direction. These great groups of closely associated meteors form great columns or streams, as it were, often several hundred thousand miles in diameter and many million miles in length. When the earth in its orbital motion passes through one of these great streams of meteors, grand meteoric showers are witnessed. At times, as in 1833 and 1866, the sky seems ablaze with meteors rushing through the heavens, thousands crossing the earth's atmosphere every second. In such cases the meteors seem to be moving so compactly that on the average only a few hundred yards separate one meteor from another; but this is most exceptional, for were the meteors separated from one another by an average distance of several miles, a brilliant shower would be visible, owing to the rapidity with which the earth and meteors pass each other. In general many miles separate the meteors from each other in an ordinary stream. The number of meteors in one of these large streams must be immense—it must be millions of millions of millions—yet their average size is so small (scarcely as large as a marble) that the entire mass, if collected, would probably not be sufficient to form a medium-sized minor planet. The great majority of such streams probably do not contain sufficient matter to form a planet even a couple of miles in diameter.

Meteors.

Meteoric showers.

FIG. 70.—THE HEAVENS AS SEEN FROM THE SURFACE OF SATURN.

The last class of bodies moving round the sun in the solar system are the mysterious *Comets*, bodies about whose nature very little is really known. Some of them seem to be immense volumes of highly attenuated glowing gas, and others appear to be closely connected in some manner with the meteor streams which have been already mentioned. The dimensions of many of the comets are very great—many having volumes millions of times as great as that of the largest planet, and at times they are accompanied by bright tails many millions of miles in length. Yet their mass is very small, far smaller than that of the smallest of the eight principal planets; and even the largest comet probably has a far less mass than the average of the minor planets. The comets, like all the other members of the solar system, move in elliptical orbits, but in orbits of great eccentricity, so that their length is much greater than their breadth. The comets may be divided into two great classes—namely, those of short period, and those of long period. The former, some score of which are known, move round the sun in from three to thirty years; whilst the latter, numbering perhaps twice as many, require periods ranging between seventy and seven hundred years. There are a few whose period comes between the two. Some of these comets are bright enough to be conspicuous to the naked eye, but most are only to be seen with a telescope: these latter are known as *telescopic comets*.

XXVI.

THE VERB.

§ 171. Classification of Verbs.
§ 172. Reflexive verbs.
§ 173. Middle verbs.
§ 174. Six notions with a verb.
§ 175. *Mood.*
§ 176. Imperative mood.
§ 177. Infinitive.
§ 178. Verbal noun and present participle.

IN every language the VERB, the word of action and existence (see before, §§ 80, 81), demands much attention from the student, on account of the very numerous shades of thought, touching time, manner, person, and others, both definitely and indefinitely, which it can be made to express. English is no exception to this, although the forms of inflexion are much simpler than those of other tongues; the ideas are there, and the method in which they are expressed must be carefully noted. Grammarians differ as to some of the details of the system in which they arrange the facts of verbs; but the main lines are the same, and these are the most important to understand.

§ 171. Verbs are classified in two ways: *first* according to their power and significance, *second* according to their inflexion—two distinct sets of facts. To begin with the first: In a former chapter the difference between TRANSITIVE and INTRANSITIVE verbs was pointed out; the transitive being that which acts upon an object, as "he cuts bread," the intransitive that which is complete without an object, as "he runs" (§§ 82, 83). It was further shown that transitive verbs are divided into the ACTIVE and PASSIVE VOICES, according to the relative positions of the verb and its object (§ 84). Among those intransitive in their nature were mentioned the IMPERSONAL and AUXILIARY verbs (§§ 87, 88).

§ 172. When a verb is used with a reflexive pronoun (§ 161), as "Jane has cut herself." "I warm myself," it is called a REFLEXIVE verb; these from their nature belong to the *active* division,—the subject *I* acts upon the object *myself*, both referring to one and the same person.* There is no special form belonging to the reflexive verb in English, as in some languages.

§ 173. Some of the transitive verbs can be used not only in an active and passive sense, but in an intermediate sense, which is explained as a *passive sense with active form:* such are "the tea *tastes* sweet," "a coat *wears* well;" with each we can say "*taste* the tea," "I wear a coat" (act.), "the tea is tasted," "the coat is worn" (pass.); the middle use, however, conveys a sense of personal quality belonging to the subject.

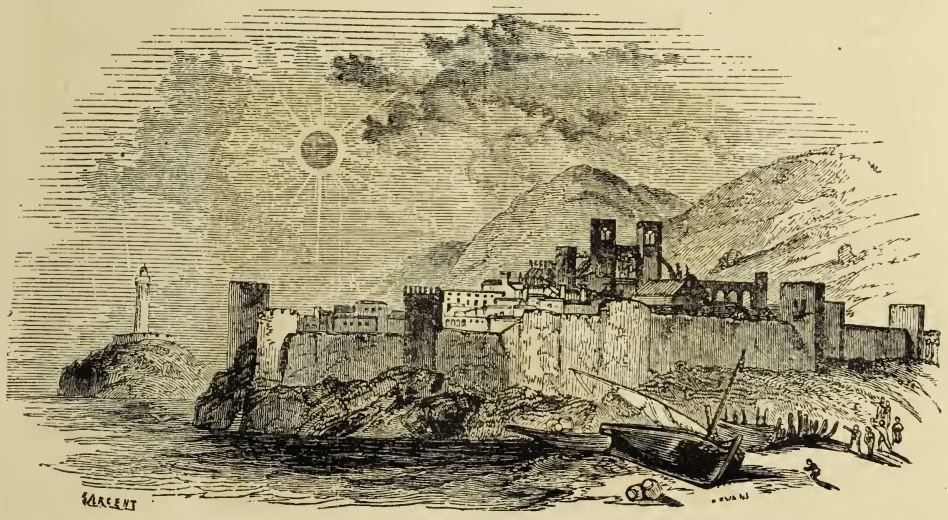


FIG. 3.—ANNULAR ECLIPSE.

§ 174. Besides the two great Classes, and the two Voices with the smaller groups which partake of the character of either voice, four other notions belong to verbs—viz., *Mood*, *Tense*, *Number*, and *Person*. That is, we can, with regard to one word in a sentence, point out six collateral ideas that it conveys to the mind (when we look for them), besides its one central thought of action!† Take an example before proceeding to definitions: "Tom *reads* a book." Of the verb *reads* we learn that the action of "Tom" passes to the object "book," and that the action passes direct; it is therefore (1) *transitive*, and (2) of the *active voice*; the

* Occasionally we meet a sentence in which the object *self* appears to be suppressed, the verb having the sense of a reflexive—*e.g.* "he keeps out of the way"="he keeps *himself* out of the way."

† The verb standing *alone* could not have these powers; the words in a sentence act and re-act upon each other, but the verb is the centre.

mode of action is simply stated, in (3) the *indicative mood*; we see that Tom is reading at some point of time in the present, which we call (4) the *present indefinite tense*; the word is in the form proper to be used by one Tom, of whom we are speaking, it is therefore said to be (5) of the *singular number*, and (6) of the *third person*.

§ 175. **Moods** (Lat. *modus*, manner). There are four moods besides the participle: the *Indicative* (Lat. *indico*, I point out), which states a fact or asks a question; the *Subjunctive* (or joining-under), by which a possibility, dependent on something else, is expressed; the *Imperative* (*impero*, I command), giving the language of command, wish, or prayer; the *Infinitive* (*infinitus*, without bound), which states the name of the action merely, and contains the verbal nouns, while the *Participles*, described before (§§ 85, 86), are verbal adjectives.

Examples: I *stand*, he *shall stand*, they *were standing*, you *have stood*—INDICATIVE.

If he *stand*, unless you *stood*, "I cannot tell whether you *stand* fair," "tell me how you *were standing*"—SUBJUNCTIVE.

"You do not know what it is *to stand* here all day," "he made me *stand* still," "here is a *standing*-desk" (*i.e.* a desk to stand at)—INFINITIVE.

A *standing* joke, a *flying* kite, a *beaten* army, a *written* letter—PARTICIPLES.

See further as to the *Subjunctive* mood, § 199.

§ 176. The *Imperative* is only used in the second person, singular and plural, for which the verb is unchanged. In the old English of the southern dialect the plural ended in *th*:—"clotheth you mid godes armes," "habbeth amang you rest" (Kentish Sermons by Dan Michel, A.D. 1340). Where in some other languages the verb is inflected for the first and third persons, we press the auxiliary *let* into service, as "*let* me give," "*let* us bring," "*let* him go," "*let* them jump."

§ 177. The *Infinitive* is simply the noun or name of the action. It has now lost the distinctive termination *en* or *an* which belonged to it in old English, and the particle "to" is generally used before it: "I am going *to die*." Generally used, but not always: the infinitive preceded by an *auxiliary* verb does not take "to." Ex.: "Let us *do* or die," "we must *brave* our fate," "you can *bear* the pain," "may I *grant* your wish," "I dare *say*." (*Ought* is an exception: it takes "to," as in "he ought *to love* you.") Custom also allows the sign of the infinitive to be omitted after a few other verbs: "I made them *sit* down," "he had better *come* home," "I bid you *depart*."

§ 178. The *Verbal Noun*, or *Gerund*, ends in *ing*, like the present Participle; the distinction between them is that the gerund can be used *like a noun* as the object or subject of a sentence, and can be pointed out by a demonstrative adjective, it can also take a preposition before or after it.

The *Participle*, however (whether present, passive, or past), is used as an *adjective*, and refers to some noun or pronoun in the sentence. A few examples show this difference, which is rather difficult for the beginner.

Verbal Noun:—

"After the *perusing* of the same."
ARBER'S *English Garner*, ii., p. 25.

"For your *coming* in to dinner."
Merch. of Venice, Act III., sc. v., l. 68.

She is to be had for the *asking*.

"That would be a reason for *liking* it."
Polly, a Village Portrait.

"It is evil *waking* of a sleeping hog."
HEYWOOD'S *Proverbs*.

"For the *barring* of the door, O."
Old ballad.

"All his faculties being resolv'd into a spirit of *contradicting*, *disputing*, and *wrangling* upon anything, etc."
Clarendon's History, Book XI.

Present Participle:—

"The king, *meaning* our company, sent word."
ARBER'S *English Garner*, ii., p. 25.

"Here he was, all fresh and *glowing*."
Polly, a Village Portrait.

"Bridget, *inflaming* her face over the kitchen fire."—*Ibid.*

"Their father *making* such pitiful dole over them that all the beholders take his part with weeping."—*As You Like it*, Act I., sc. ii., l. 140.

Three of these examples give an instance of both Verbal Noun and Participle; in the quotation from Clarendon "being" is a participle, as also "sleeping" in Heywood's Proverb; while in the line from *As You Like it*, "weeping" is a verbal noun.

XXVII.

DECIMALS.

A FRACTION which has for its denominator 10 or any power* of 10 is called a "Decimal Fraction," or for shortness a Decimal.

Thus, $\frac{3}{10}$, $\frac{7}{100}$, $\frac{31}{10000000}$, are decimals.

By an extension of the ordinary method of notation for integer numbers, we are able to express such fractions without writing down their denominators.

We saw that in the ordinary notation for integers each figure has a local value as well as an absolute value.

In any number the first figure, beginning at the right hand, denotes so many units, the second so many tens, the third so many hundreds, and so on. For instance, in the number 77777, the first 7 on the right hand denotes 7 units, the second 7 tens, the third 7 hundreds,

* A power of a number is the product of that number multiplied by itself any number of times, as has been shown already. Thus the first power of 10 is 10; the second power of 10 (written 10^2) is 10×10, *i.e.* 100; the third power of 10 (written 10^3) $=10\times10\times10=1000$; $10^4=10\times10\times10\times10=10{,}000$, and so on. So $3^2=3\times3=9$, $5^3=5\times5\times5$, and so on.

and so on. Thus a figure in the second place denotes 10 times as much as it would in the first place; a figure in the third place denotes 10 times as much as it would in the second; and generally the local value of the figures *increases* tenfold as we proceed from right to left, and therefore *diminishes tenfold as we proceed from left to right.*

Hence, if we write figures to the right of the units figure and agree to let the local value of these figures decrease in the same proportion, the first of such figures would denote so many tenths, the second so many hundredths, the third so many thousandths, and so on.

But we must have some mark to show us where the units place is, since all the other figures take their local value according to their position with regard to the units place. The mark used for this purpose is a dot, or full stop, placed near the top of the line, and immediately after the units figure. This mark is called the "decimal point."

Thus, 34·17 means 3 tens + 4 units + 1 tenth + 7 hundredths, or $34 + \frac{1}{10} + \frac{7}{100}$.

The usual way to read such a number as this is "thirty-four, decimal one, seven."

So the number ·0306 denotes $\frac{0}{10} + \frac{3}{100} + \frac{0}{1000} + \frac{6}{10000}$, or $\frac{3}{100} + \frac{6}{10000}$, and is read "decimal 0, 3, 0, 6."

We observe that the fraction corresponding to the first figure has one 0 in its denominator, that corresponding to the second has two 0's, and in general the number of 0's in the denominator of the fraction corresponding to any figure is the same as the number of that figure's place in the decimal number.

For instance, the fraction corresponding to the 7 in the number ·523007 will be $\frac{7}{100000}$, because 7 stands in the sixth place from the decimal point.

We can now give rules for converting a fraction expressed in the decimal notation into the ordinary fractional notation.

We have explained that ·17 means $\frac{1}{10} + \frac{7}{100}$, and this by addition is $= \frac{17}{100}$.

Similarly ·0306 $= \frac{3}{100} + \frac{6}{10000} = \frac{306}{10000}$ by addition.

In both these cases we observe that the numerator is the decimal number considered as an integer, and the denominator is 1 followed by as many 0's as there are decimal places in the given decimal. Hence we have the following

Rule to express a decimal as a vulgar fraction.

For numerator write down the figures which compose the decimal, omitting the decimal point, and for denominator write 1 followed by as many 0's as there are places in the decimal.

Examples: ·176 $= \frac{176}{1000}$; ·0031 $= \frac{31}{10000}$; $17{\cdot}0103 = 17\frac{103}{10000}$.

Conversely a fraction having any power of 10 for its denominator can be expressed in the decimal notation by writing down its numerator and putting a decimal point as many places to the left of the units figure of the numerator as there are 0's in the denominator, making up the required number of places by 0's if necessary.

For instance, $\frac{103}{10000} =$ ·0103.

Here we have to make up a fourth place by a 0, because there are four ciphers in the denominator.

Thus, also, the improper fraction $\frac{73201}{1000} = 73{\cdot}201$, for as there are three ciphers in the denominator, there must be three decimal places.

In a decimal the figures 1, 2, 3, 4, 5, 6, 7, 8, 9, are called "significant" figures.

We observe that writing 0's to the right of a decimal does not alter its value, because this does not alter the place of any significant figure. Thus, ·17 = ·170 = ·1700, for expressed in fractions these are respectively $\frac{17}{100}$, $\frac{170}{1000}$, $\frac{1700}{10000}$, which are evidently equal.

But when placed between the decimal point and the decimal number, each 0 so placed diminishes the value of the decimal tenfold, because this moves each significant figure one place further to the right of the decimal point.

Thus, ·17 is altered to one-tenth of its value by writing it ·017, and to $\frac{1}{100}$th of its value by writing it ·0017, for ·17 $= \frac{17}{100}$, ·017 $= \frac{17}{1000}$, and ·0017 $= \frac{17}{10000}$.

Exercises.

1. Express as vulgar fractions, or as mixed numbers, the following decimals:—

·75; ·037; ·55050; 13·2470; ·0247; ·0008; ·503; ·050030; 10·10; 1·010; ·1010; 1010·0.

2. Express as decimals the following fractions:—

$\frac{1}{10}$; $\frac{2}{100}$; $\frac{3}{1000}$; $\frac{10}{10}$; $\frac{12}{100}$; $\frac{13}{1000}$; $\frac{50}{10}$; $\frac{162}{100}$; $\frac{273}{1000}$; $\frac{4555}{10000}$; $\frac{45}{100000}$; $13\frac{7}{10}$; $1\frac{3}{100}$; $572\frac{572}{100000}$; $\frac{5720}{10000000}$.

3. Assuming that ·037 expresses what we have explained above, show that it must be equal to $\frac{37}{1000}$.

Answers.

1. $\frac{75}{100}$; $\frac{37}{1000}$; $\frac{5505}{100000}$; $13\frac{247}{1000}$; $\frac{247}{10000}$; $\frac{8}{10000}$; $\frac{503}{1000}$; $\frac{5003}{10000000}$; $10\frac{1}{10}$; $1\frac{1}{100}$; $\frac{101}{1000}$; 1010.

2. ·1; ·02; ·003; 1; ·12; ·013; 5; 1·62; ·273; ·4555; ·00045; 13·7; 1·03; 572·0572; ·000572.

3. ·037 $= \frac{0}{10} + \frac{3}{100} + \frac{7}{1000} = \frac{37}{1000}$.

BOTANY.

XXVII.

The Fungi.

LEAVING the Algæ, of which we give several illustrations on the three following pages, we proceed to speak of the Fungi.

The Fungi.

In the Fungi we have the most distinct and remarkable of all the families of vegetable nature. So different are they from the accustomed types of vegetation, even when most highly and beautifully developed, that there have not been wanting men who would exclude them altogether from the realm of flora. A celebrated German once proposed to regard them as constituting a fourth kingdom of nature, the

arrangement he thought called for being, Animals, Plants, Minerals, Fungi. It has been supposed, also, that they are of animal origin, corresponding, after some odd fashion, with corals; and by a very bold speculator it was once suggested that perhaps they may be the corpses of "fallen stars" — those well-known lovely meteors, trails or streaks of silvery light, which the poet called the "tears of the sky." Science has long since determined their constitution and place in the scale of nature, which, as we said in our last article, is abreast of the Lichens and the Algæ. Considered as to their larger and commoner forms, no plants are more easily recognised. The familiar edible mushroom, the toadstools of the rubbish heap and the wayside, are not only known to everybody, but instruct us as to the complexion of thousands besides; and pursuing our observation a little further, in common mildew, such as appears upon decaying fruit, we have an index to the aspect of a still vaster number—for the multitude of singular growths which legitimately fall under the name of "fungoid," or of fungus nature, appears to be almost boundless. In Great Britain alone there have been discovered upwards of 4,000 species large and small, or 2,500 more kinds than there are of flowering-plants and trees.

FIG. 160.—LAMINARIA FASCIA.

The Fungi are composed, like the Algæ and the Lichens, purely of cellular tissue, though in some cases this assumes a somewhat fibrous or filamentous form. The thallus below the surface of the ground, the pillar and the round cap of such as the mushroom, are absolutely homogeneous. The composition may be compared to that of cork, to which, indeed, many fungi bear a close resemblance also in colour and durability. The accustomed parts and organs of flowering-plants, of course, are not to be looked for, any more than in the two companion families. They have neither roots nor stems nor leaves. The organs which represent flowers are not separable; and the atoms which represent seeds are discharged in the form of impalpable powder. A capital illustration of the "spores," as we must call the seed-like efflux, is supplied by the common puff-ball, from which, on being squeezed between the fingers, they gush out like smoke.

Substance of the Fungi.

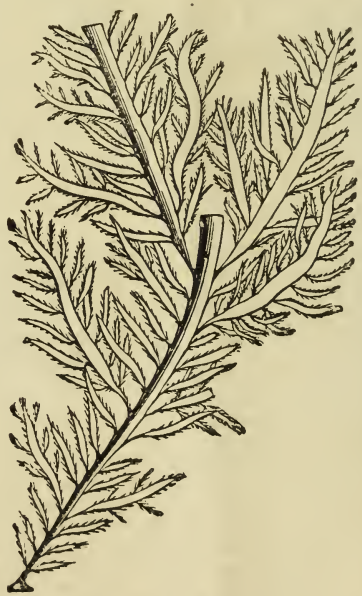


FIG. 161.—DESMARESTIA LIGULATA.

In dimensions they vary from the microscopic to lumps of a foot or more in diameter, some having more of a horizontal mode of extension, while others, such as the mushroom, are of erect and umbrella-like habit. The fructification is immensely various, fungi of the mushroom type developing their spores from the under surface of the cap or "pileus"—the particular portion yielding them being called the "hymenium"; while in the beautiful little organisms termed "cluster-cups"—microscopic occupants of the dead and dying leaves of flowering-plants—the spores are effused by the bursting open of the topmost portion, the edges falling back like a frill. To attempt to describe the fructification in detail is, in the present place, impossible. The fungi, like the Algæ and the Lichens, furnish materials for the employment of years, and no description can be rendered fairly intelligible except to one who has already studied observantly for himself. The colours are often singularly beautiful. The hue of the common mushroom gives a very slender idea of them. Brilliant scarlets, deep rich lilac and purple, golden yellow, amber, tawny, ivory white, are more or less frequent; green, on the other hand, as in the Lichens, is extremely rare, and when present it is generally comparable to verdigris rather than to grass or other foliage.

Habitats of the Fungi.

An eminent characteristic of the Fungi is that as a rule they always grow upon organic substances which, if not already dead, are dying, or on the highroad to dissolution. They seem to have been designed by nature to occupy the place given to scavengers in human society. Their work is to help to clear away what presently might become offensive and deleterious. Every one who has the slightest knowledge of the source of the mushroom is aware that it is cultivated by gardeners by introducing portions of the "thallus," horticulturally

termed the "spawn," into layers of old horse-manure, such as is used, when recent, for making "hot-beds." When growing wild in the fields, mushrooms after the same manner will always be found seated upon some kind of dead or decomposing animal product; and the same rule will apply to every description of toadstool. Very many kinds are found vegetating upon the dead bark of old trees, especially stumps that have been cut down, and upon timber that is decaying. No matter what may be the particular habitat, the story is the same—carrying off the decomposing and converting it into new substance, which by-and-by in turn breaks up and disappears, the elements returning to the atmosphere and the soil, to serve in the old incessant round of alternate life and death. For all that we call "death" is preparation for new life, and a gateway to it. Every end in nature is at the same moment a new beginning. All sepulchres and graves are simultaneously cradles or pathways thereto:—

"See dying vegetables life sustain,
And life dissolving, vegetate again;
All forms that perish other forms supply,
By turns we catch the vital spark and die."

FIG. 163.—PHYLLOPHORA RUBENS.

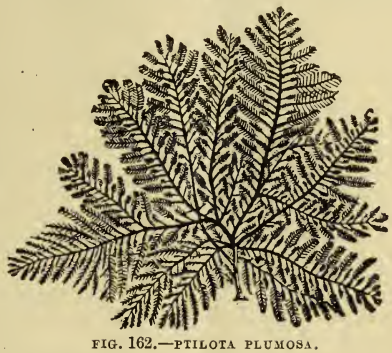


FIG. 162.—PTILOTA PLUMOSA.

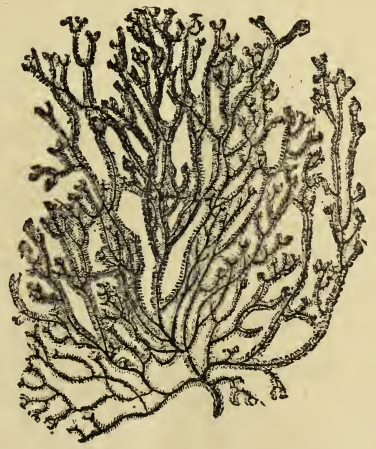


FIG. 165.—CHORDARIA DIVARICATA.

Perhaps it is because of the somewhat disagreeable office assigned to them that nature has usually made the fungi so pretty. To consider toadstools "ugly" is a vulgar prejudice. Examine one carefully, and with a desire to discover the best about it,—remembering that the first rule of wisdom is to exhaust all that is meritorious in a thing before we begin to look for the defects and blemishes, and that the second is not to suppose we are competent to assume the functions of judges while we have still to learn how to be patient and modest scholars. The pillar, round as the column of an old Greek temple; the exquisitely rounded cap, sometimes dimpled in the centre, sometimes with a boss, sometimes with elegant radiating lines, or scattered fragments of skin-like substance, that make it seem, as the ladies say, "worked"; the hymenium, in innumerable plates, or honeycombed, or curiously sinuous, as in the Dædalea, so named because of the charming similitude we get in it to a labyrinth;—all these, in one species or another, present the first requirements of artistic beauty, not to mention the colours already enumerated, with others, such as black and grey, in many shades, the aggregate of characteristics giving to these ordinarily despised toadstools the recommendations to every sincere admirer of natural beauty, which culminate, no doubt, in rose and lily, but are anticipated, if nothing more, in the most admirable manner down, down so far below. Wise men have preferences, but they never have absolute exclusions; they certainly do not exclude the humble fungi from their list of the worthy. Because of their disagreeable duty in the economy of nature, it may be, then, we repeat, that the fungi are made so pretty. It is much the same as if, to reconcile our street-sweepers and dustmen to their unsavoury occupation, the usage should be to deck them with jewels and gay apparel.

FIG. 164.—CORALLINA OFFICINALIS.

Beauty of the Fungi.

The popular prejudice against the fungi has unquestionably arisen upon the fact of some of them being deleterious, and even dangerous and deadly poisons. Mark here the important fact that of all the Cryptogamia none but the fungi, and these only now and then, are hurtful to man. But the alarm is much greater than need be. The poisonous species constitute an insignificant minority; and on the other hand there are numbers of species, many of

Properties and uses of the Fungi.

them plentiful in our own island, which are quite as good and palatable and suitable for eating as the common mushroom. A very interesting volume, with coloured drawings of the wholesome British kinds, has been published by Mrs. Hussey, and is procurable at the libraries under the title of "Edible Fungi." But no one who is not well-practised in the discrimination of the larger fungi must ever venture upon tasting and trying, much less upon swallowing, an unknown species. It is quite as likely that one of honest appearance may be poisonous as wholesome, there being no one single mark or even set of marks that will uniformly and invariably tell the vicious from the esculent. Every kind of fungus, in a word, must be learned by itself. The common mushroom gives an idea of the characters that have to be looked to; these consisting, in the present instance, in the colour of the hymenium — salmon-pink changing to black—the peculiar odour, and the skin of the pileus allowing of ready removal in little strips. Excepting these few contributions to the food of man, the fungi have little to offer that can be called useful in the economic sense. One or two, when dried, serve as the basis of a kind of slow match called "German tinder"; and one or two have been found available by physicians. Their purpose in the economy of nature, as already indicated, is to transform the foul and decaying into elegant fabrics that in themselves are usually short-lived, and in so doing to deck the woods, waysides, and meadows, with shapes of singular artistic beauty.

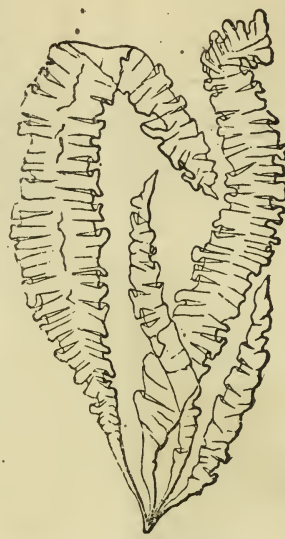


FIG. 166.—ULVA LINZA.

That in this great race there are certain species, over and above the poisonous ones, directly hurtful to crops and other human possessions, is quite true. It is doubtful, however, whether these detrimental fungi, which are always very minute, ever seat themselves upon perfectly healthy organisms. They seem rather to be always on the look-out for weakly and sickly subjects, upon which they immediately pounce, and lead them on to utter destruction. All forms of mildew and mould except the purely chemical ones, and all forms of blight except such as originate with insects, are resolvable into fungoid attacks. The potato disease, which of late years has been so terrible an affliction, some of the worst forms of "grape-disease," the "rust" in corn, and several other maladies occurring in plants, are familiar examples. In every instance it may fairly be assumed that there was a predisposition in the plant to disease, —that disease, indeed (the first step towards decay), had actually begun, though likely enough not in a form visible to the eye; the spores of the fungus which thus attacks, floating in the atmosphere, at once finding it out, and implanting themselves. Spores of parasitic fungi are probably suspended in the atmosphere in incalculable myriads, harmless to healthy subjects, but ready in an instant to fix themselves upon the sick. Their infinitesimal dimensions prevent the possibility of excluding them, no matter what precautions may be taken. Hence the common development of these active little bodies within the very substance of the thing they devour, as in the case of "dry-rot," which commences *in* the wood, not upon it or outside of it, and consists of an ever-extending thallus, the entire mass of the wood becoming at last changed into the fungus. "Dry-rot" signifies "tree" or "timber" rot. Rottenness can never come to pass except in the presence of moisture, and through the aid of moisture; so that *dry* rot, if we take the epithet in its ordinary sense, involves a contradiction of terms. "Dry" here represents the ancient Aryan word which reappears in the Greek *drus*, in "tree," and in "druid," literally one who worships amid or under the shadow of the trees.

FIG. 167.—FUCUS NODOSUS.

Destructive Fungi.

In strong contrast to the longæval lichens, the fungi, as a rule, are very short-lived. The parts which bear the fructification, at all events, are so. Every one knows how rapidly mushrooms make their appearance, and how soon they decay. Puff-balls, on the contrary, endure throughout the winter; and upon the bark of trees there occur many singular kinds, the texture of which is almost leathery, or, as already said, like that of cork, and these appear to endure indefinitely. Some of them resemble

Duration of the Fungi.

oyster-shells, only that they are destitute of the lining of pearl; to balance which deficiency they are often of a rich mahogany brown, and brightly polished on the upper surface.

A notice of the Fungi, however brief, would be incomplete without a word or two upon the

Fairy rings.

beautiful green circles so commonly seen upon hill-sides and in meadows where the sward is short and comparatively dry. The circles in question vary in width from two or three feet to a dozen yards, though becoming more and more incomplete as the size increases. That they are produced by the action of fungi is perfectly certain, the circular outline of such as the mushroom giving the start. How frequently they are referred to by the poets hardly needs mention. They are the "fairy rings," for instance, which are adverted to in that charming Shakspearian line—

"To dew her orbs upon the green."

HOW TO PASS EXAMINATIONS.

BY THOMAS DUNMAN.

PART I.—THE PREPARATION.

THE age in which we live is emphatically one of examinations. Not only in our schools and colleges, and in the learned professions, but in all our government departments, in our banks, and even in some of our large commercial establishments, the system of competitive examinations has been adopted as a means of testing the qualifications of those desirous of occupying a position in connection with them. Numerous as are the objections which have been, with more or less show of reason, urged against this system, there can be little doubt that on the whole it is, if wisely employed, productive of good, and tends to raise the level of culture in all ranks of society. But however this may be, the sturdiest opponent of the examination system must acknowledge the wisdom of the student adapting himself to existing circumstances, even if he do not exactly approve of them. Whether their influence be good or evil, it is a fact beyond dispute that examinations, and especially competitive examinations, have become, in this country at least, the recognised means of testing general capacity, as well as fitness for the discharge of special duties.

This being the case, it behoves the student of either sex who intends making use of his or her knowledge as a means of making way in the world to cultivate the art of displaying it to the best advantage when called upon to do so. It is a somewhat remarkable fact, that while every competitor in an athletic contest takes the utmost pains to train himself for it, the competitors in an intellectual contest rarely give a thought to preparation for the display of the knowledge they possess. Success in an athletic contest depends not merely upon the possession of physical strength and agility, but upon the manner in which the special physical quality required is displayed and made use of. For this reason those who intend entering into a competition of this description "go into training" for a lengthened period before presenting themselves for the contest. The man who trusted merely to his great strength and powers of endurance would be infallibly beaten in a race by a man of inferior qualifications in this respect, but who had been carefully trained; for while the former would be "out of condition," and would moreover waste his physical powers through the want of the knowledge how best to apply them, the latter would have the tone of every muscle and the tension of every nerve at their highest point, and would husband his strength so as to apply it to the very best advantage.

Precisely the same conditions obtain in an intellectual contest, although the fact seems to be generally ignored. The present writer, as one having considerable experience as an examiner, is constantly struck with the almost total absence of training displayed by examinees. The general idea of candidates seems to be that the only essential of success in an examination is the possession of a heterogeneous knowledge of certain subjects, which knowledge is to be shot out pell-mell at the feet of the examiner, as if from a sack; and there can be no doubt that the want of success on the part of many results from this want of aptitude in the display of their knowledge. As we confidently hope that many of the readers of the UNIVERSAL INSTRUCTOR will have the courage to submit their knowledge to the test of an examination, we feel sure that a word of friendly advice upon the necessary preparation will not be altogether unwelcome.

In preparing for any examination, it is necessary at the very outset to obtain as full particulars as can be had of the exact requirements of the examiners; when this is obtained it should be made the syllabus of the course of study. Having in this way adopted a general plan of the task to be accomplished, it will be necessary to set systematically to work; and in order to do this the time at the student's disposal must be carefully taken into account. It need hardly be said that this time should be as ample as possible; anything like hurry should be most carefully avoided, as it is fraught with much danger to health, and is, if for this reason alone, by no means conducive to success. Having as far as possible mapped out the time at his disposal (always allowing a fair margin in case of unforeseen interruptions), the student should adhere to it as rigidly as possible. Let each day see completed the portion of work allotted to it, and above all things avoid driving off work until the last moment. Just as the stomach requires time to digest the food supplied to it, so does the brain need time in order that it may assimilate knowledge. "Cramming up" just a few days before an examination is a great mistake, even if viewed only from the low standpoint of success in satisfying the examiners.

But in addition to systematically acquiring knowledge the student should be careful to confine himself, as far as possible, to just such knowledge as is required, and not to spread his energies over too wide a field. Most examining bodies specify very fully the exact extent of knowledge required in each subject. When this is the case the student should get the book or books which treat specially these branches of the subject, and however interesting the other branches may be, their study should be deferred to a more convenient season. Instances constantly occur where students neglect the elements of a subject and study the more advanced portions. This plan is not only illogical—it is disastrous, and can never lead to a successful prosecution of a study, nor will such knowledge stand the test of an examination. We would therefore earnestly caution students to be careful in their selection of text-books. Remember that the book required is not necessarily the best general work on the particular subject in question, but the one best adapted to the end in view. Many works of our best authors, though extremely valuable from a literary standpoint, are by no means adapted (as they were never intended by their authors to be), for the purposes of the student, who will find many less pretentious works much more serviceable. As an instance which will make our meaning perfectly clear, we may mention the case of a student who lately came under our notice. This gentleman, being desirous of obtaining an elementary knowledge of the history of Greece, selected as his text-book the voluminous work of the late Mr. Grote, —a work which from a general point of view is of course beyond all praise, but which is totally unfitted for the purposes of an elementary student.

But in addition to the acquisition of knowledge the student should endeavour to prepare for its display. Most examinations are conducted by means of writing, the candidate having to supply written answers to printed questions. This fact should be kept in view from the very commencement of the term of preparation, and the student should take every opportunity of committing his knowledge to writing. Many examining bodies publish their old examination papers; and these should be procured, and as each division of a subject is studied the questions relating to this division should be answered, and the answers verified by reference to the text-books in use. It is in this exercise that the student will find the best preparation for the examination; but to be of use it must be carried out with the most scrupulous honesty. Do not copy the answer from your text-book, even if you do not know it. Carefully study the point referred to in the question, then close the book and write the answer in your own words, writing it over and over again if necessary; never leave a question until you have thoroughly mastered it. Continue this method throughout the entire term of preparation, cultivating a clear, concise style of expression, and *confining yourself strictly to the subject of the question.* Above all things, remember Scrooge's advice to Marley's ghost—"don't be flowery." Many students make their answers more like rhetorical harangues than calm statements of facts or explanations of phenomena. Female students seem to be particularly liable to fall into this error: some answers which have come under the writer's notice read more like pages from a gushing novel than extracts from examination papers.

In conclusion, we would earnestly warn our readers against "cram" of every kind. Happily, many examiners are doing their best

SITE OF THE CITY OF ON.

to discourage cramming, by cancelling papers which give evidences of it; but it is still possible to pass some examinations by its aid. The aim, however, of the honest student is the *possession* of knowledge, and not merely the *reputation* of possessing it; and this can only be secured by patient, conscientious, and persevering work. The individual who succeeds in passing an examination by unworthy means is an impostor, and his success a fraud.

XXIV.

EGYPT.

WHEN the great Babylonian empire, of which we have sketched the history, was in its in-

critics, having regard to the plural form of the word, are disposed to regard the expression as figurative, implying that the people occupying the land known as Mizraim were descendants of Ham who had wandered south-west and established colonies in the fertile district now known as the Delta, and had spread through the valley of the Nile as far as the borders of the land generally described as Ethiopia, equivalent to the modern Nubia.

Like that of Babylon, the most authentic history of Egypt is to be found recorded on its monuments; and the two histories have this in common, that it is only in very recent times— within the present century, indeed — that scholars have been able to decipher the records. What the Behistun inscription did by affording a key to the cuneiform writing, the Rosetta stone—a mass of black basalt, covered with inscriptions in hieroglyphics, a "demotic" or cursive style, and Greek, which may be seen

Monumental records.

THE SPHINX AND THE PYRAMIDS.

fancy, a cluster of independent or semi-independent petty states, with small towns scattered in the plains watered by the Tigris and Euphrates, there was a powerful kingdom, probably several kingdoms, with large populations, versed in many arts, with at least an elementary knowledge of many sciences, in the long narrow African valley through which the mysterious Nile pours its waters to the sea, and on the broad alluvial plains formed by the deposits of the river and intersected by its many channels.

Of the very early history of Egypt we know absolutely nothing with certainty, and can only get a glimpse here and there by the aid of the faint rays of light afforded by allusions and hints in other histories. In the book of Genesis the country is named Mizraim, which name is also given as that of a SON of Ham; but modern

in the great Egyptian gallery at the British Museum—did for the interpretation of the monumental inscriptions. But the earliest inscriptions known, the oldest monuments, pyramids and others, do not carry back to a period anterior to about 2500 B.C.; while the traditions preserved by the priests of later times, and by them communicated to Greek writers, claim for the Egyptian kingdom an enormous antiquity.

There is an important difference between the Babylonian and Egyptian monumental records and architectural antiquities. The former lay buried for more than two thousand years unknown to the world, and their discovery was a veritable revelation to the historical inquirer. Egyptian temples, pyramids and tombs, statues, inscriptions and pictorial representations have stood in the open

light of day since the time of the Pharaohs, and stand so still; propounding, like the majestic silent Sphinx, a riddle to the world which no Œdipus for thousands of generations could answer. Alexander saw them, so did Cæsar, so did Napoleon; and the grand faces of the colossal statues smiled massively serene on the Macedonian conqueror who had crossed the Indus and the Corsican conqueror who had subdued Italy. Greek travellers, in the great days of Greek culture, wandered curiously in the halls of the temples, received from the lips of the priests legends of dynasties and kings, found in the mysterious land the cradle of their own arts, sciences, and literature, and with Greek facility constructed histories which passed almost unquestioned, until the slab of black basalt, captured in 1799 by the French at Rosetta, yielded to the eager search of Champollion, Young, and others, the key by which they became masters of the secret of the monumental inscriptions.

The first of the Greek writers on Egyptian history was Herodotus (see vol. i., p. 31), who in the fifth century before the Christian era visited Egypt and collected from the priests of Heliopolis various legends and lists of kings, to which he added many interesting descriptions of matters which came under his own observation relative to the political and social condition of the people. His account of Egypt forms the second of the nine books of his history, and bears the name of the Muse Euterpe. It is extremely interesting, but as a history valueless. Herodotus, says a modern critic, "is the representative writer of a class who stand midway between poetical annalists, like Homer, and critical historians, like Thucydides. They wrote their Iliads in prose, making no sharp distinction between truth and fiction. They did not look upon the verification of their facts as a duty, but jotted down all that they heard and saw—an instinctive love of truth alone suggesting occasional scepticism as to very extraordinary marvels."

Herodotus.

The chief informants of Herodotus on the history of the country were, as we have said, the priests of Heliopolis, the great seat of learning at that time. The city, as the Greek name signifies, was dedicated to the sun, and had been for untold centuries the place where sun-worship was most predominant. The Egyptian name was An, and in the book of Genesis it is mentioned as On; but in the later prophetic books it bears the name Beth-Shemesh. Poti-pherah, whose daughter, Asenath, the Israelite Joseph married, was prince-priest of On. The town, of which some remains are still to be traced, stood about twenty miles to the north-east of Memphis, on the eastern side of the Pelusaic channel of the Nile. In the midst of the ruins still stands an obelisk, which, we are assured, "certainly stood in its present position in the days of Joseph."

The community of priests at Heliopolis had treasured up certain traditions, and possessed some hieroglyphic records of the annals of the country, which probably they very imperfectly understood, but from which they constructed, for the benefit of the inquiring Greek, narratives which for authenticity are about equal in value to most of the early monkish chronicles of the western world, with the extra attraction that they extend over almost illimitable periods of time. It is also to be noted that Herodotus did not understand the language of the country, and that consequently his communications with the priests were carried on by means of interpreters, so that a very large margin of misunderstanding and error in respect to periods and personages may reasonably be allowed for; besides which his Greek guides appear to have related to him many vulgar fables and legends, which he seems to have considered to be of equal authenticity with the graver statements of the priests.

About a hundred years after the visit of Herodotus, a learned Egyptian priest, Manetho, who wrote in the Greek language, compiled a history of Egypt, of which extracts, quoted by Josephus in his work against Apion, and an epitome compiled by Eusebius and other ecclesiastical writers in the fourth Christian century, are all that we possess. Manetho describes a mythic period, "the reign of the gods," extending over a period of nearly 25,000 years, followed by thirty royal dynasties, from the line of Menes, the first mortal king, to the conquest of Egypt by Alexander. The mythic period we may for the present dismiss from our minds. It represents "the unknown" in history, affording a vast field to the imagination; and whether it extends over years or thousands of years is a matter of indifference to the historic investigator. Diodorus of Sicily, who compiled his famous history of the world in the first century before Christ, was evidently indebted for much of his Egyptian material to Manetho, and like him (and Herodotus before him), asserts that the first king of Egypt was Menes, assigning to the thirty dynasties a duration of 4700 years.

Manetho.

That Manetho was substantially correct in his record of the succession of the dynasties, may be taken as almost certain; but that his dates are to be relied on is another matter. By the aid of the monuments and inscriptions, modern Egyptologists are enabled to throw some light on the vexed question of chronology; but the subject is still wrapped in considerable obscurity. The most eminent of modern investigators, Bunsen, Lepsius, Wilkinson, Sharpe, Poole, Rawlinson, Mariette, Brugsch, and Birch, are far from agreeing as to the date when the first of the thirty dynasties began, M. Mariette fixes it at 5004 B.C.; Brugsch at 4400 B.C.; Bunsen at 3643 B.C.; Lepsius, 3892 B.C.; Poole, 2717 B.C., and Dr. Birch, the keeper of Oriental Antiquities in the British Museum, assigns a date of "about" 3000 B.C. An original document, of great antiquity, known as the Turin papyrus, gives a list of dynasties generally agreeing with that of Manetho, but differing in some important respects, especially as to dates.

It seems likely that there were several kingdoms, and that some of the dynasties given by Manetho as successive were really contemporaneous.

Sequence of the dynasties.

It has been suggested that, even before the reign of Menes (who is himself a very mythical person), there were two distinct states; and when we are first able to get a glimpse of authentic history (about 1700 B.C.) we meet with evidences of the existence of a kingdom of Memphis, occupying the western half of the Delta, in the north; of Thebes, farther north, and probably including the valley to the east of the Nile, for it had a port on the Red Sea; of This, on the western side of the Nile; of Elephantine, on the confines of Nubia; and on the eastern part of the Delta the less important kingdoms of Bubastis and Tanis. In enumerating the first seventeen dynasties, Manetho groups them as Thinites, Memphites, Elephantinites, etc. If these dynasties were successive, there must have been almost constant warfare and successive conquests; if the enumeration, however, is not intended to be consecutive, but if the monarchs of the various states reigning at the same time are reckoned, the long space of time over which the dynasties appear to extend would be very greatly reduced, and the chronology brought more into harmony with that of other countries. Indeed, in a passage referring to the expulsion of the Hyksos, or Shepherd Kings (whom we shall notice in due course), Manetho speaks of the kings of the Thebais and the rest of Egypt uniting to expel the foreign rulers, which clearly implies that the whole of the country was not under one rule.

Whoever the earliest inhabitants of the Nile country may have been, they had, probably, mostly migrated from the districts afterwards known as Syria and Phœnicia. They were addicted to agricultural rather than to pastoral pursuits, and found in the rich alluvial land of the Delta a favourable place of settlement. It is remarkable that, by unmistakable indications in the hieroglyphic records of Egypt, husbandmen were highly esteemed, while herdsmen and shepherds were held in great contempt. The paintings on the earliest monuments represent the inhabitants of the country as a red or a dusky race, "neither entirely Caucasian nor Nigritic," says Dr. Birch. At a later period there appears to have been an infusion of a darker race; and still later, "at the most flourishing period of their empire, the sallow tint and refined type of the Semitic families of mankind. The Nigritic or black races appear on the monuments as a distinct people; and certainly there was little in common between the Egyptians, remarkable for mental and physical development, and the natives of Ethiopia."

Earliest inhabitants.

Dr. Birch thus describes the position of the Egyptians in relation to neighbouring tribes or nationalities: "South of Syene lay the numerous black tribes, the so-called Nahsi, or Negroes, inferior in civilization, but turbulent and impatient of subjection. The skirts of the eastern desert were held by wandering tribes called Satu, not yet subjected to the arms and discipline of Egypt. The western frontier was menaced by the Tahennu, or Libyans. Beyond the north-eastern desert, in which resided the Herusha, or 'inhabitants of the waste,' were the Menat, perhaps also a shepherd race, the dwellers of northern (the most northern part then known) Asia; and hazily in the distance were seen the nascent forms of the empires of Babylon and Assyria, and the slowly rising power of the Phœnician states and Syrian kingdoms."

XXV.

Fusibility of the Metals.

THE temperature at which the different metals pass from the condition of a solid to that of a liquid is termed "the point of fusion," and will be found to vary immensely for these bodies—mercury becoming liquid at 40° below freezing-point, while iron requires a heat of from fifteen to sixteen hundred degrees.

Various temperatures of fusion.

Table of Melting Points.

Mercury	—40°
Tin	+235°
Lead	334°
Zinc	423°
Silver	1000°
Copper	1090°
Cast iron	1000 to 1200°
Wrought iron	1500 to 1600°

Iron possesses the property of assuming a soft or pasty condition long before the heat of fusion is reached, in which it can be what is termed welded—that is, beaten into any form, and one piece can be made to unite with another by hammering.

Condition of iron when heated.

Doubtless all the metals give off more or less vapour at high temperatures, and mercury actually boils at 350°, while arsenic passes into vapour without assuming the intermediate liquid state, and hydrogen must be assumed to be a metal so volatile as to exist in the gaseous state at the lowest known temperatures. Gold possesses a greater degree of tenuity or power of cohesion than any other metal. It is therefore the most malleable as well as the most ductile of metals—that is to say, it may be beaten into leaves of exceeding thinness, or drawn into wire of more than hair-like fineness. Some metals, such as antimony and bismuth, are so brittle as to pulverize under the hammer.

Metals in the gaseous state.

Attributes of gold.

Specific Heat.

The amount of heat taken up by the same proportion by weight of different bodies, when raised through the same number of degrees of temperature, varies very considerably. To give an example of what we mean, if equal weights of mercury and water, say a pound of each, be raised to the same temperature, it can be

Definition of specific heat.

proved that the water has taken up thirty-three times as much heat as the mercury; hence the specific heat of mercury is said to be $\frac{1}{33}$ or 0·033 of that of water. In the case of the metals the specific heat has been found to vary with the atomic weight, being least for those metals whose atomic weight is greatest, and greatest for those whose atomic weight is least; thus, while in the case of lead, whose atomic weight is 207, we find the specific heat to be ·031, in the case of silver, whose atomic weight is 108, or little more than half that of lead, we find the specific heat to be ·059, or nearly double. It will be seen, therefore, that the specific heat is in inverse ratio to the atomic weight, and by multiplying the one into the other, we obtain a result which is nearly the same for all the metals, and is termed the atomic heat; thus in the case of the metals specified, if the atomic weight of lead, 207, be multiplied by ·031, we get 6·41 as the result, and the atomic weight of silver multiplied into its specific heat will be found to give 6·37; differing, as will be seen, but very slightly from that of lead. It is evident, therefore, that the known specific heat of a metal affords a means of determining its atomic weight, if not to a nicety, at least within limits that may be regarded as fairly accurate.

Specific heat and atomic weight.

Atomic heat.

ICE CRYSTALS.

METALLURGY.

This term is applied to the art of breaking up, by chemical action, those compounds in which most of the metals are found to exist in a state of nature, so as to liberate the metal in the free or uncombined condition. Some few metals are met with in the free state in nature, but most of them have to be obtained by the reduction of their ores. While some of the metals, among the number of which are calcium, aluminium, magnesium, sodium, and iron, occur very abundantly—indeed, may be considered of almost universal distribution throughout the globe, in combination with other elements—other of these bodies are very rarely met with, and only in very minute quantities. The metals, as before stated, may be arranged into certain groups, in accordance with their natural attributes or chemical properties. Without enumerating all, we will mention a few of these classes—the metals of the alkalis, metals of the alkaline earths, metals of the earths, the iron class, the gold class, the zinc class, etc.

Condition of the metals in a state of nature.

Unequal distribution of metals.

Metals arranged into groups.

ALLOYS.

The compounds which the metals form with one another are termed alloys. Many of these possess very valuable properties not exhibited by the metals separately. Gold and silver, for example are in the pure state, comparatively speaking, soft and pliable; before being manufactured, therefore, into articles of jewellery or coined into money, they are rendered harder by the addition of some other metal or metals in the shape of alloy. In brass, bronze, gun-metal, bell-metal, type-metal, etc., we have other examples of useful alloys. As a rule, the fusing point of the alloys is lower than that of the metals, their constituents; by a judicious combination of various readily fusible metals, an alloy can be produced whose melting point is considerably below the temperature of boiling water. Spoons made of such a metal would therefore melt in a cup of hot tea or coffee. Long before the recent experiments of Mr. Pictet appear to have demonstrated the fact of the metallic nature of hydrogen, an alloy of this gas had been formed with a metal termed "palladium," affording strong presumptive evidence of its being itself a metal. The alloys of the metals with mercury are termed "amalgams."

Uses of alloys.

Low fusing point of alloys.

It has already been shown that natural substances like iodine and sulphur have a tendency, under certain conditions, to assume a special structure known as the crystalline form. Many of the ores, or compounds of the metals with the non-metals, are found in a state of nature as crystals. The same substance may exist in several different allotropic modifications, in what is termed the amorphous as distinguished from the crystalline form. This is true of many of the salts, some of which require to unite with more or less water before they can become crystallised. In addition to their definite geometrical structure, crystals exhibit what is known as cleavage—that is to say, they are susceptible of being split up in certain directions only. Many crystals also, such as Iceland spar, tourmaline, selenite, etc., exhibit the phenomenon of double refraction or polarization. The same substance may crystallise in different forms; at the same time almost every body exhibits some special typical form of crystal by which it may be distinguished from all others.

Crystalline state of metallic compounds.

Attributes of crystals.

Various forms of crystals.

Crystals of the same body may, however, differ very materially in size, according to the more or less favourable circumstances under which they have been formed: as a rule, the more gradually they are formed the larger the crystals. Manifold as are the forms assumed by different substances, frozen water for example, on entering into the crystalline state, it has been found possible to arrange them into six sets or systems.

Classification of crystals.

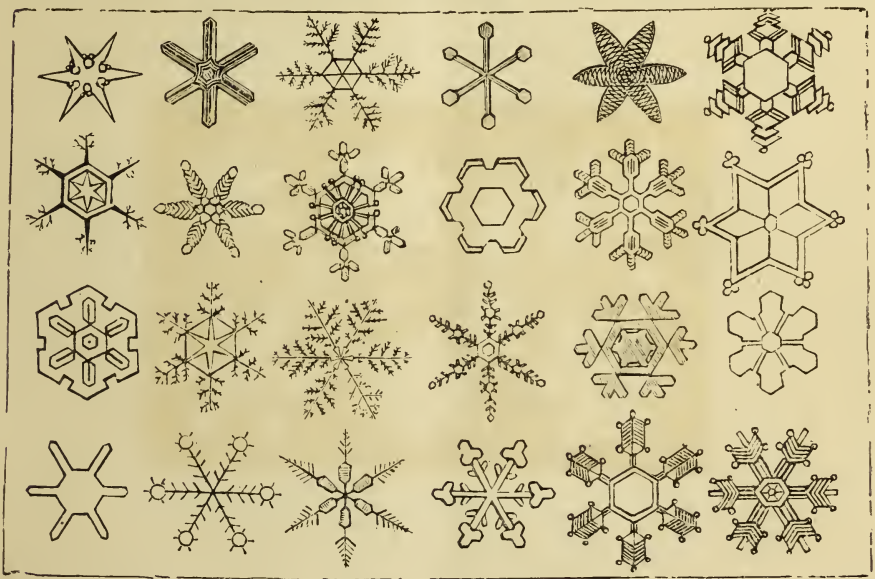
Crystallography is, however, a branch of science in itself, and can be studied by those who desire to become more intimately acquainted with it; the subjoined plates will give a better idea of some of the forms assumed by bodies in this condition, than any mere verbal description.

THE METALS OF THE ALKALIS.

We have already stated that the metals may be divided into classes. The first we shall speak of is that of the alkaline metals, or alkalis, the best known of which are sodium and potassium; but lithium, the newly discovered metals of cæsium and rubidium, and lastly the quasi-metal ammonium, belong to the same group. The alkalis had always been regarded as elements until their dual or compound character was revealed by Sir Humphrey Davy, in the year 1807, and they were shown to be the oxides of two metals.

Metals of the alkalis.

In the felspar of the granitic rocks we find the potassium compounds combined with silicic acid .They enter into most natural soils, and are assimilated by many plants, from which they may be obtained by burning. Sea-water forms another inexhaustible source of potassium salts, from which it appears probable they will in future be principally derived.



SOME FORMS OF SNOW CRYSTALS.

GERMAN.

XXVIII.

STUDY ON THE DECLENSION OF ADJECTIVES.

English Version for correcting and re-translating into German.

LONDON is a great, beautiful, and rich city. In the long and broad streets are shops, in which costly wares are to be seen (to see). The reign of the good old King George was a very long (one). A faithful friend remains faithful in dangers. The old proverb says, "Sweet water and good counsel are often scarce on (board) ship." In every kind sentence of the long letter one saw the loving father. Napoleon the First was sagacious, hard-working, and very ambitious. The sly fox is dangerous through his malice. A rough block requires a rough wedge. Still waters run (ground) deep. Blue mountains, green valleys, dark glaciers, are found (one finds) in Switzerland. The heavy heart becomes not light by words. I cannot give thee my (the) hand; remain thou in life eternal, thou good comrade. The clear white wine which wells from the spring is a good wine for children. A little man, a great horse, a short arm, a long sword. must help one another. With great thanks the merry boy took the beautiful book which his kind friend gave him. Long grass grows in the wide plains of Asia. With bold courage the brave soldier fought against the wild enemies of his fatherland. My dear friend, you have here made a bad fault. In an open space of the town (of) Haarlem stands the lofty statue of

the celebrated Lawrence Coster. The rose is a beautiful flower. A man came once into a little town, and said he had a green donkey to sell. A part of the United States of America is a great flat country, with broad rivers. The fresh aspect of a neighbouring well in the hot desert of Arabia brings new life into the exhausted limbs of the weary wanderer. With great courage and praiseworthy industry the old navigator traversed the unknown sea. The Simoom, or poison-wind of the desert, becomes dangerous through the great waves of glowing sand which it carries with it.

STUDY FOR READING AND PRONUNCIATION.

Die Treue.

dee troy'-e

(THE) FAITHFULNESS.

Ein heidnischer[1] König ließ einen
ine hide'-nish'-er koe-nich leess i'-nen
A heathen king (caused, let) a

frommen Bischof vor sich kommen und
from'-men bish'-off fore sich kom'-men unt
pious bishop before him come, and

verlangte, daß er den christlichen
fer-lang'-te dass airr dane krist'-lich-en
demanded that he the Christian

Glauben[2] verleugnen[3] und den Götzen[4]
gloy'-ben fer-loig'-nen unt dane goet'-zen
belief deny and to the idols

opfern sollte. Der Bischof aber sprach:
op'-fern soll'-te dare bish'-off ah'-berr spraach
saerifiee should. The bishop however spoke:

„Mein Herr und König, das thue ich
mine hairr unt koeh'-nich dass too-e ich
"My lord and king, that do I

nicht." Da ward[5] der König zornig
nicht dah vahrt dare koeh'-nich tsor'-nich
not." Then became the king angry

und sprach: „Weißt du nicht, daß dein
unt spraach vysst doo nicht dass dine
and spoke: "Knowest thou not that thy

Leben in meiner Gewalt[6] stehet, und daß
lay'-ben in my'-ner ge-valt' stay'-et unt dass
life in my power stands, and that

ich dich tödten kann? Ein Wink von mir
ich dich toet'-ten kann ine vink fon meer
I thee kill ean. A sign from me

und es [7]geschieht." „Das weiß ich," antwortete
unt ess ge-sheet' dass vice ich ant'-vor-te-te
and it happens." "That know I," answered

der Bischof, „aber gestatte mir vor-
dare bish'-off ah'-ber ge-stat'-te meerr fore-
the bishop, "but allow me be-

her, daß ich dir ein Gleichniß[8]
hairr dass ich dearr ine glych'-niss
fore, that I to thee a parable

vorlege und eine Frage zur Entschei-
fore-lay'-ge unt i'-ne frah'-ge tsoor ent-shy'-
offer and a question for deci-

dung.[9] Gesetzt,[10] einer deiner treuesten
doong ge-zetst, i'-ner dy'-ner troi'-es-ten
sion. Suppose one of thy most faithful

Diener fiele in die Gewalt deiner Feinde,
dee'-nerr feel'-e in dee ge-valt' dy'-ner fine'-de
servants fell into the power of thy enemies,

und sie suchten ihn zur Untreue zu
unt zee zooch'-ten een tsoor un'-troi-e tsoo
and they sought him to unfaithfulness to

bewegen, damit er ein Verräther[11]
be-vay'-gen dah'-mit airr ine fer-ray'-terr
move, so that he a traitor

an dir würde. Aber als dein
an deerr vuerr'-de ah'-berr als dine
to thee should become. But when thy

Diener unverrückt[12] beharrte[13] in seiner
dee'-nerr un-fer-ruecht' be-harr'-te in zy'-nerr
servant unshaken persisted in his

Treue, nahmen ihn deine Feinde, zogen[14]
troi'-e nahm'-en een dy'-ne fine'-de tso'-gen
faithfulness, took him thy enemies, drew

ihm die Kleider aus und jagten ihn
eem dee kly'-der ouss unt yahg'-ten een
him the clothes off and chased him

nackend mit Spott von dannen.[15] Sage
nack'-end mit spott fon dan'-nen zah'-ge
naked with revilings from thence. Tell

mir, mein König, wenn nun dein Diener
meerr mine koeh'-nich venn noon dine dee'-nerr
me, my king, when now thy servant

zu dir kommt, würdest du ihm nicht
tsoo deerr kommt vuerr'-dest doo eem nicht
to thee comes, wouldst thou (to) him not

von deinen besten Kleidern geben und ihm
fon dy'-nen best'en kly'-dern gay'-ben unt eem
of thy best clothes give and him

die Schande mit Ehren vergelten?" Da
dee shann'-de mit ayr'-ren fer-gelt'-en dah
the shame with honour repay." Then

antwortete der König: „Nun wohl; aber
ant'-vor-te-te dare koen'-ich noon vole ah'-ber
answered the king: "Now well; but

was soll[16] dies, und wo ist es
vass soll deess unt vo ist ess
what means this, and when has (is) it

geschehen?"[17] Da sprach der Bischof:
ge-shay'en dah sprahch dare bish'-off
happened?" Then spake the bishop:

„Siehe, du kannst mich auch entkleiden
zee'-e doo kannst mich ouch ent-kly'-den
"See, thou eanst me also unclothe

von dem irdischen Gewande[18] meines
fon dame eerr'-dish-en ge-vand'-e my'-nes
from the earthly elothing of my

Leibes;[19] aber ich habe einen Herrn,
ly'-bess ah'-berr ich ha'-be i'-nen hairrn
body; but I have a Master,

meinen Gott, der wird mich neu bekleiden.
my'-nen gott dare veerrd mich noi be-kly'-den
my God, He will me anew elothe.

Sollte ich nun des Kleides achten[20] und
soll'-te ich noon dess kly'-dess ach'-ten unt
Should I now of the elothing be careful and

die Treue brechen die ich meinem Herrn
dee troi'-e brech'-en dee ich my'-nem hairrn
the faith break which I to my Master

schuldig,[21] bin?" Da sah der König
shuld'-ich bin dah zah dare koe'-nich
owe (owing) am?" Then saw the king

wohl daß der fromme Bischoff Recht
vole dass dare from'-me bish'-off recht
well that the pious bishop right

hatte; und er dachte: Dieser Mann,
hat'-te unt airr dach'-te dee'-zer mann
had (was) and he thought: This man
der seinen Gott ehrt, wird auch seinem
dairr zy'-nen gott airrt veert owch zy'-nem
who his God honours, will also his
irdischen Herrn treu dienen.
irr'-dish-en hairrn troy dee'-nen
earthly master faithfully serve.

REMARKS ON THE FOREGOING STUDY.

[1] *Heidnisch*, literally heathenish. The ending *isch* in German generally expresses the nature—as *Schelmisch*, roguish; *Persisch*, Persian, etc.; while *lich* expresses likeness or similarity.

[2] *Der Glaube* (gen. *ns*), belief, faith: thus *Glaube, Hoffnung, und Liebe*—Faith, hope, and charity.

[3] *Verleugnen*, the transitive form of *Leugnen*, to deny (from *Lug*, deceit; *die Lüge*, the lie).

[4] *Der Götze*, the false god; also, *das Götzenbild*, the idol.

[5] *Ward* is the second form of the imperfect indicative of *werden—ich ward, du wardst*, etc. The ordinary form is *Ich wurde, du wurdest*.

[6] *Gewalt* is power forcibly exerted; thus, *Er risz ihn gewaltsam fort*, he tore him forcibly away.

[7] *Geschehen* (imp. *geschah*, past p. *geschehen*), to occur, to happen. *Es geschieht oft*, it often happens; hence *die Geschichte*, history, story (*i.e.* that which has happened).

[8] *Das Gleichnisz*, the parable or similitude (from *gleich*, like). Thus the proverb: "*Gleich und gleich gesellt sich gern*" (Like and like associate gladly); equivalent to the Latin "*Similis, simili gaudet*," and the English "Birds of a feather, etc."

[9] *Entscheiden*, to decide (imp. *entschied*, p. part. *entschieden*)—from *scheiden*, to divide, or part. Hence *der Unterschied*, the difference.

[10] *Gesetzt*, literally "set" (as a question); the past participle from *setzen*, to set.

[11] *Verräther*, one who betrays "*Rath*" or counsel.

[12] *Unverrückt*. The verb *rücken* means, literally, to move. Thus *verrücken* (to advance, move forward) is said of a body of troops: *zusammen rücken*, to move close together, to gather; and an insane person is said to be *verrückt*—his brain is pushed aside or askew.

[13] *Harren* (whence the English to tarry), to wait; *beharren*, to persist.

[14] *Ausziehen* (imp. *Ich zog aus*, past part. *ausgezogen*), to undress—literally to draw off (the garments); *Anziehen*, to dress (to draw on); *der Anzug* (*ann'tsooch*), the dress or costume; *abziehen* (to draw away), to go away, also to deduct.

[15] *Von dannen* is a somewhat obsolete expression, seldom used now except in poetry. The ordinary word is *davon: Er ging davon*, he went away.

[16] This is an elliptical phrase, part of the meaning being unexpressed. "*Soll*" is literally "shall": *Was soll dies bedeuten?* what shall this mean or signify? the *bedeuten* being understood.

[17] *Geschehen* (imp. *es geschah*, past part. *geschehen*), to happen, is an impersonal verb, like the English "it behoves."

[18] *Das Gewand*, the garment, is a poetic word like "raiment"; the ordinary word is *das Kleid*, pl. *die Kleider*.

[19] *Der Leib* is the body in contradistinction to the soul; *der Körper* the body anatomically or literally considered; *die Leiche* (*Ly'che*) the dead body.

[20] *Achten*, to respect, or heed—is now generally used with the accusative case, especially where the object is a person: *Ich achte dich, aber du achtest mich nicht*, I respect thee, but thou dost not respect me.

[21] *Schuldig*, indebted, owing; also used in the sense of guilty: *unschuldig*, innocent; *schuldig*, guilty. "*Vergib uns unsere Schuld*," "Forgive us our debt (trespasses)."

EXERCISE ON THE FOREGOING STUDY.

To be translated into German, and compared with the German version and inverted sentences given below, for correction. (Note the position of the verbs *in subordinate clauses.)*

There was once a heathen king, who demanded of a pious bishop that he should sacrifice to idols, and thus deny the Christian faith. But the bishop would not do that. Then the angry king said: "Thy life is in my hand. I can kill thee if I will. It requires only a word from me." The bishop answered: "I know that thou canst kill me; but, my lord and king, if thou wilt allow (it) me, we will say that one of thy most faithful servants had fallen into the power of thine enemies, and they wished to make him unfaithful to thee; but thy servant remained faithful to thee, his master. Then thine enemies took him, took off his clothes from him, and drove him away. When thy servant shall come to thee, wilt thou not give him new clothes for those which they have (one has) taken from him, and wilt thou not bring him to honour, because he has remained faithful to thee?" "That I would," answered the king; "but what has that to do with thee? and where has (is) this happened, whereof thou speakest?" "Behold," said the pious bishop, "if thou unclothest me of this earthly raiment (my body), my Lord and God will give me a new and a richer garment. Shall I not then remain faithful to my Lord?"

German Version of the above.

Da war einmal ein heidnischer König,
dah vahr ine'-mahl' ine hide'-nish-er koe'-nich
der von einem frommen Bischoff verlangte,
dare fon i'-nem from'-men bish'-off fer-lang'-te
daß er Götzen opfern sollte, und also
dass airr goet'-sen op'-ferrn zoll'-te unt al'-zo
den Christlichen Glauben verläugnen.
dane krist'-lich-en glow'-ben fer-loig'-nen
Aber der Bischoff wollte daß nicht
ah'-berr dare bish'-off voll'-te dass nicht
thun. Dann sagte der zornige König:
toon dann zaach'-te dare tsor'-ni-che koe'-nich
„Dein Leben ist in meiner Hand. Ich kann
dine lay'-ben ist in my'-ner hand ich kann
dich tödten, wenn ich will. Es braucht nur
dich toet'-en venn ich vill es browcht noor
ein Wort von mir." Der Bischoff antwortete:
ine vort fon meer dare bish'-off ant'-vor-te-te
„Ich weiß daß du mich tödten kannst;
ich vice dass doo mich toet'-en kannst
aber mein Herr und König, wenn du es
ah'-ber mine herr unt koe'-nich venn doo es
mir erlaubst, wir wollen sagen daß
meerr airr'-lowbst' veerr vol'-len zah'-gen dass
einer deiner treuesten Diener in die
i'-ner dy'-ner troy'-es-ten dee'-ner in dee
Macht deiner Feinde gefallen wäre, und
macht dy'-ner fine'-de ge-fal'-len vair'-re unt
sie wünschten ihn dir untreu zu machen;
zee vuensh'-ten een deerr un'-troy tsoo mach'-en
aber dein Diener blieb dir, seinem
ah'-ber dine deen'-er bleeb deerr zy'-nem
Herrn, treu. Dann nahmen ihn deine Feinde,
hairrn troy dann nahm'-en een dy'-ne fine'-de
zogen ihm die Kleider aus, und trieben
tso'-gen eem dee kly'-der owss, unt tree'-ben
ihn fort. Wann dein Diener zu dir
een fort vann dine dee'-ner tsoo deerr

kommen wird, wirſt du ihm nicht neue
kom'-men veert veerrst doo eem nicht noy'-e
Kleider geben für diejenigen welche
kly'-derr gay'-ben für dee yay'-ni-gen vell'-che
man ihm genommen hat, und wirſt du ihn
man eem ge-nom'-men hat unt veerrst doo een
nicht zu Ehren bringen weil er dir
nicht tsoo ayren bring'-en vile airr deerr
treu geblieben iſt?" „Das würde ich,"
troy ge-blee'-ben ist dass vuerr'-de ich
antwortete der König; „aber was hat
ant'-vor-te-te dare koe'-nich ah'-ber vass hat
das mit dir zu thun, und wo iſt dieſes
dass mit deerr tsoo toon, unt vo ist dee'-ses
geſchehen wovon du ſprichſt?" „Siehe,"
ge-shay'-en vo-fonn doo sprichst zee'-e
ſagte der fromme Biſchoff, „wenn du
zahch'-te dare from'-me bish'-off venn doo
mich von dieſem irdiſchen Gewande
mich fon dee'-zem eart'-dish-en ge-van'-de
meines Leibes entkleideſt, wird mein Herr
my'-nes ly'-bes ent-kly'-dest veerrt mine herr
und Gott mir ein neues und reicheres Kleid
unt got meerr ine noy'-es unt ry'-che-res klide
geben. Soll ich dann nicht meinem Herrn
gay'-ben zoll ich dann nicht my'-nem herrn
treu bleiben?"
troy bly'-ben

Britain; and some of the Tertiary strata on the Continent are probably older than any belonging to the same group in this country. But of the interval which they represent, we have no record in England, and we do not know how far they fill up the gap between the Secondary and Tertiary formations. The very convenient classification of the Tertiary strata into *Eocene*, *Miocene*, and *Pliocene*, we owe to Sir Charles Lyell.*

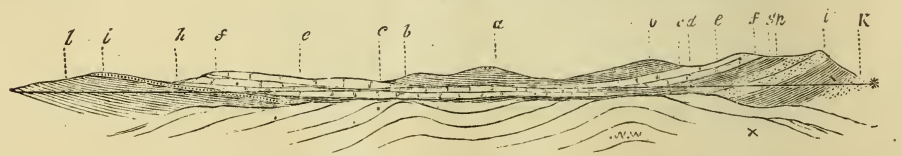
Classification of Tertiary strata.

Limiting our attention for the present to Great Britain, we find that the Tertiary rocks are almost entirely confined to the south-east of England—the lowest or Eocene beds being shown in the London and Hampshire "basins"; the Pliocene or uppermost formations in Suffolk and Norfolk, and the Miocene or Middle Tertiary being represented by lacustrine deposits in Antrim and Mull, the lignites of Bovey Tracey (also lacustrine) in Devonshire, and, according to Sir Charles Lyell, by the fresh-water and estuarine strata of Hempstead in the Isle of Wight.

Their occurrence in Great Britain.

The London basin, as before explained, is a shallow trough or wrinkle in the chalk, which is bounded on the east by the sea, on the west by the Marlborough Downs, on the south by the North Downs, and on the north by the chalk of Berkshire, Oxfordshire, Buck-

The London and Hampshire basins.



SECTION ACROSS THE LONDON BASIN (W. WHITAKER).

a Lower Bagshot sand (of Hampstead). *b* London clay. *c* Reading and Woolwich beds (including the Oldhaven beds, which occur in the south only). *d* Thanet sand (crops out on the south only). *e* Chalk with flints. *f* Chalk without flints. *g*. Upper Greensand (crops out on the south only). *h* Gault. *i* Lower Greensand. *k* Wealden beds (on the south only). *l* Oolitic clays (shown only on the north, but proved to occur on the south beyond the range of the section, by the sub-Wealden boring, near Battle, in Sussex). × Old rocks, shown by borings at Kentish Town and at Meux's Brewery, to pass under the London basin.

XXI.

TERTIARY (OR CAINOZOIC) PERIOD.—EOCENE.

WE have no means of ascertaining the length of time which elapsed between the deposition of the chalk and the formation of the oldest of the Tertiary strata: it may have been and probably was of immense duration, but we are very much left to conjecture on the subject. We know, as mentioned in our last chapter, that at Maestricht and elsewhere there are deposits which, though classified with the chalk, are evidently of later date than the cretaceous beds of Great

Interval between the Secondary and Tertiary deposits.

inghamshire, Hertfordshire, and thence by the Essex hills to the sea. The accompanying diagram, which is a section through the London basin from north to south, shows the succession of Eocene strata thus enclosed, and their relation to the older beds. The Hampshire basin is a similar shallow synclinal curve, extending south as far as the chalk situated in the Isle of Wight, and extending east and west from Beachy Head, in the county of Sussex, to the neighbourhood of the towns of Salisbury and Dorchester.

* It is as well for the student to observe that the first of the above terms, Eocene, is derived from ηος (*eos*), "dawn," and καινος (*cainos*), "recent," because the shells of this period contain an extremely small proportion of living species, which may be looked upon as indicating the dawn of the existing state of the testaceous fauna, no recent species having been detected in the older or secondary rocks. The term Miocene—from μειον (*meion*), "less," and καινος (*cainos*), "recent," is intended to express a minor proportion (of testacea); the term Pliocene—from πλειον (*pleion*), more, and καινος (*cainos*), "recent," a comparative plurality of the same.—*Lyell.*

The *Thanet beds*, which lie at the base of this series in the London basin, are fine soft unfossiliferous sands, near London, but become more clayey and fossiliferous farther eastward. They are of variable thickness, and thin out towards the north and west; being about sixty feet thick in the Isle of Thanet (whence they receive their designation), and four feet thick at East Horsley in Surrey, the most westerly point to which they have been traced. Their presence under London has been ascertained by numerous well borings, but they do not occur (except very doubtfully) on the northern edge of the London basin. An interesting feature in connection with these sands is the occurrence at their base of a clayey bed, with numerous green grains, and at the bottom a layer of unworn green-coated flints. This bed is rarely over and commonly under five feet in thickness, and is believed to have been caused by the action of water charged with carbonic acid soaking through the sands and slowly dissolving the surface of the chalk beneath.

The Thanet beds.

The fossils of the Thanet sands are sufficiently conclusive as to their marine origin. A few fish remains are occasionally met with; and in the list of fossils recorded as occurring in them are: *Nautilus*, various species of *Dentalia*, *Fusus*, *Natica*, *Cardium*, *Corbula*, *Cucullæa*, *Cyprina*, *Cytherea*, *Glycimeris*, *Nucula*, *Ostrea*, *Pectunculus*, etc. Fragments of silicified wood are not uncommon, and a fossil fern and the cone of a Pinites have also been obtained from these beds. They do not occur in the Hampshire basin.

Their fossils.

TEETH OF LAMNA.

The *Woolwich and Reading beds* succeed the Thanet sands in ascending order, and where these latter are absent they repose directly on the chalk. They consist of variegated clays and sands and pebble beds, and in the neighbourhood of London are fossiliferous and decidedly estuarine in character, as they are also at Newhaven. Elsewhere in the Hampshire basin they are unfossiliferous, as they generally are in the northern and western portions of the London basin. In East Kent they usually consist of light-coloured sands with marine fossils. At Woolwich they are composed of beds crowded with shells; in the neighbourhood of Reading they are rarely fossiliferous,—hence the compound name. "In thickness," says Mr. Whitaker, "this formation varies from about fifteen feet in the far west to eighty or ninety feet in some of the deep wells under London." "Eastward from London it again thins, and in the farther part of Kent is but twenty-five feet thick. Northwards, too, in parts of Hertfordshire, it is about the same."

NUMMULITES PUSCHI (from the Pyrenees).

a External surface of one of the nummulites. *b* Longitudinal section. *c* Transverse section showing the chambers of the nummulites.

The most characteristic fossils of the Reading and Woolwich beds are *Melania inquinata*, *Cerithium funatum*, *Pitharella Rickmanni*, *Paludina lenta*, *Ostrea tenera* and *O. bellovacina*, *Corbula Regulbiensis*, *Cyrena cordata*, *C. cuneiformis* and *C. deperdita*, etc. The remains of a tapir-like animal, the *Coryphodon*, have been found at Dulwich, with bones of turtles and scutes of crocodiles. Fish remains and bones of birds have also been found. Plant remains are not uncommon, but they are generally too imperfectly preserved to be identified; but the following species from these beds at Reading have been figured: *Dryandroides Prestwichi*, *Ficus Forbesi*, *Ficus Prestwichi*, *Grevilea Heeri*, *Lannis Hookeri*, *Robinia Readingensis*. The clays of the Reading and Woolwich beds have been worked from time immemorial for bricks, tiles, and coarse pottery.

Their flora and fauna.

The *Oldhaven beds*, or as they are sometimes designated the *Oldhaven and Blackheath beds*, come next in order. They occur as "perfectly rolled flint pebbles in a fine sandy base, or as fine sharp light-coloured quartzose sand." They are pebble beds at Blackheath, and sand beds at Oldhaven Gap, east of Herne Bay, and it is to mark this difference that the double name has been suggested. These beds are local, are limited to the eastern part of the London basin, and occur on both sides of the Thames. They clearly indicate an old coast-line, and the most remarkable feature about the pebble beds is the fact that they are all well worn: a partially formed pebble is never met with, and one of any other material, if ever found, is of the rarest possible description. They must therefore have been formed at a distance from the chalk from whence the flint was originally derived, otherwise angular and subangular pieces—such as are now to be seen on any chalk shore—would be found amongst them. The thickness of the Oldhaven beds is variable up to about fifty feet; they are sometimes fossiliferous, and have been separated from the Woolwich and Reading beds below and the London clay above mainly because the fossils are of an intermediate character, consisting of *Calyptræ*, *Cerithium*, *Fusus*, *Melania*, *Natica* and *Neritina*, *Cardium*, *Cyrena*, *Ostrea* and *Pectunculus*, etc., etc.

Oldhaven beds.

The *London clay* is a deposit of stiff clay, brown near the surface, and bluish or slate-coloured when obtained from any depth. Its greatest thickness is

London clay.

above 500 feet (in the Isle of Sheppey). It is sometimes 400 feet or more in thickness in the neighbourhood of London, when, as at Hampstead, it has been preserved by a capping of Bagshot sands. Elsewhere it is very variable in this respect, as shown by deep well borings, of which there have been many in different parts of the London basin. It occurs also in the Hampshire basin ; but the Bognor beds and the sandy clays at Portsmouth are generally distinguished from the London clay proper, on account of some differences in their fauna and mineral character ; though it is believed that they are really the equivalents of the lower part of this formation in the London basin. The *basement bed* of the London clay is a loamy and pebbly deposit, more or less fossiliferous, *Ditrupa plana*, a marine annelid, being very common and characteristic.

In places the London clay is rich in fossils, the best known localities being Highgate and the Isle of Sheppey. At Sheppey an immense number of fossil fruits and other vegetable remains have been found, with teeth and bones of birds, reptiles and fish. "The plants have long been celebrated, consisting of various palm-nuts, *Nipadites ellipticus* and *N. umbonatus* and other fruits ; coniferæ, many leguminous plants, laurels, figs, junipers, and plants of the citron tribe, are also common, all of extinct species. Remains occur of birds allied to the vulture (*Lithornis vulturinus*) and kingfisher (*Halyeornis toliapicus*) and a small swimming bird, described by Owen, with tooth-like serratures on the bill ; turtles and river tortoises are numerous, of the genera *Chelone* (*breviceps*, etc.), *Emys* (*Conybeari*, etc.), *Platemys* and *Trionyx*, also a crocodile (*Crocodilus champsoides*), and snakes (*Palæophis toliapicus*, and *P. longus*). Terrestrial mammals also occur [in other localities]. A marsupial (*Didelphis Colehesteri*), a bat, and *Hyracotherium cunieulus*, also *Miolophus planiceps*, *Pliolophus vulpieeps*, and *Coryphodon eocænus*, which are tapir-like animals, in a distant way allied to the tapirs now found on the banks of South American rivers."*

Its flora.

The fish, of which sixty genera have been found in the London clay, include fourteen species of *Myliobates* and several species of *Lamna*. The mollusca include several species of *Nautilus*, *Belosepia*, *Cassidaria*, *Cerithium*, *Cypræa*, *Dentalium*, *Fusus* (fourteen species), *Murex* (five species), *Natiea*, *Pleurotoma* (a great variety of species), *Pyrula*, *Turritella*, *Voluta*, *Area*, *Cardium*, *Corbula*, *Cytherea*, *Leda*, *Nucula*, *Ostrea*, *Pecten*, *Pectunculus*, *Teredo*, etc., etc., with brachiopoda, crustacea, annelida, echinodermata, foraminifera, etc.

And fauna.

"Looked at in a comprehensive way," says the writer just quoted, "an accurate observer cannot fail to be struck with the fact that the assemblage of fossils found in the London clay point in this direction—viz., that the whole of these strata were deposited in the estuary of a great continental river comparable to the Amazon and the Ganges. The palm-nuts and the host of other plants help to prove it, and the remains of river tortoises, crocodiles, snakes, marsupials, and several tapir-like mammals, all point in the same direction. The estuarine conditions begun during the deposit of the Woolwich and Reading beds were still going on when the London clay was thrown down; with this difference, that by sinking of the area the estuary had become longer, wider, and deeper, but still remained connected with a vast continent, through which the Eocene river flowed." One feature of considerable economic importance is the occurrence in the London clay of Septaria or cement stones, which are used in the manufacture of Roman cement, for which purpose they are worked at Sheppey and elsewhere. The London clay is also extensively used for bricks, tiles, and pottery.

The London clay partly an estuarine deposit.

The formations just described, from the Thanet sands to the London clay inclusive, are grouped together to form the *Lower Eocene*. The *Middle Eocene* is represented in the London basin only by the Bagshot beds, which are shown in the diagram as they are to be found at Hampstead ; they take their name, however, from the occurrence of the upper division at Bagshot. These beds are usually sandy, with occasional layers of loam and clay, and pebble beds, and in the London basin are unfossiliferous or nearly so—only a few indistinct remains of marine shells being found in them occasionally. At Harrow and Highgate, at High Beech and in other parts of Essex, the Bagshot sands cap the London clay hills, as they do at Hampstead.

Bagshot beds in the London basin.

* Ramsay, "Physical Geography and Geology of Great Britain."

XXIX.

Irregular Perfects and Supines (*continued*).

Verbs the stems of which end in the Dentals **d, t.**

(1) Perfect—**si.** Supine—**tum.**

Note.—*d* and *t* are generally dropped before *s*, and sometimes changed into *s*.

claudo,	clausi,	clausum,	claudĕre,	to shut.
dīvīdo,	dīvīsi,	dīvīsum,	dīvīdĕre,	to divide.
lædo,	læsi,	læsum,	lædĕre,	to strike, to injure.
lūdo,	lūsi,	lūsum,	lūdĕre,	to play.
plaudo,	plausi,	plausum,	plaudĕre,	to clap the hands.
rādo,	rāsi,	rāsum,	rādĕre,	to scrape.
rōdo,	rōsi,	rōsum,	rōdĕre,	to gnaw.
trūdo,	trūsi,	trūsum,	trūdĕre,	to thrust.
invādo,	invāsi,	invāsum,	invādĕre,	to go against.
cēdo,	cessi,	cessum,	cēdĕre,	to yield.
mitto,	mīsi,	missum,	mittĕre,	to send, and compounds.

(2) Perfect with reduplication.

cădo,	cĕcĭdi,	cāsum,	cădĕre,	to fall.
cædo,	cĕcĭdi,	cæsum,	cædĕre,	to strike, to cut.
pendo,	pĕpendi,	pensum,	pendĕre,	to hang, to weigh.
tendo,	tĕtendi	tensum, tentum,	tendĕre,	to stretch.
tundo,	tŭtŭdi	tunsum, tūsum,	tundĕre,	to beat.

Do in composition :—

abdo,	abdĭdi,	abdĭtum,	abdĕre,	to put away, to hide.
addo,	addĭdi,	addĭtum,	adděre,	to put to, to add.
condo,	condĭdi,	condĭtum,	conděre,	to put together, to build, conceal.
dēdo,	dēdĭdi,	dēdĭtum,	dēdĕre,	to put down, to surrender.
edo,	ēdĭdi,	ēdĭtum,	ēdĕre,	to put forth, to publish.
indo,	indĭdi,	indĭtum,	indĕre,	to put in.
perdo,	perdĭdi,	perdĭtum,	perdĕre,	to ruin, to lose.
prōdo,	prōdĭdi,	prōdĭtum,	prōdĕre,	to betray.
reddo,	reddĭdi,	reddĭtum,	redděre,	to put back, to restore.
subdo,	subdĭdi,	subdĭtum,	subdĕre,	to put under, to substitute.
trādo,	trādĭdi,	trādĭtum,	trādĕre,	to put across, to deliver.
crēdo,	crēdĭdi,	crēdĭtum,	crēdĕre,	to believe.
vendo,	vendĭdi,	vendĭtum,	venděre,	to sell.
sisto,	stĭti,	stătum,	sistĕre,	to cause to stand.

(3) Perfect—**i.** Supine—**sum.**

accendo,	accendi,	accensum,	accendĕre,	to set on fire.
cūdo,	cūdi,	cūsum,	cūdĕre,	to hammer.
ĕdo,	ēdi,	ēsum,	ĕdĕre,	to eat.
dēfendo,	-fendi,	-fensum,	-fendĕre,	to ward off, to defend.
offendo,	-fendi,	-fensum,	-fendĕre,	to strike against, assault.
fundo,	fūdi,	fūsum,	fundĕre,	to pour.
incendo,	-cendi,	-censum,	-cendĕre,	to burn or kindle.
mando,	mandi (rare),	mansum,	mandĕre,	to chew.
pando,	pandi,	pansum or passum,	pandĕre,	to spread.
prĕhendo,	-hendi,	-hensum,	hendĕre,	to grasp.
scando,	scandi,	scansum,	scandĕre,	to climb.
verto,	verti,	versum,	vertĕre,	to turn.
findo,	fĭdi,	fissum,	findĕre,	to cleave.
scindo,	scĭdi,	scissum,	scindĕre,	to tear.

Anomalous forms.

mĕto,	messui,	messum,	mĕtĕre,	to mow.
pĕto,	pĕtīvi or pĕtii,	pētītum,	pĕtĕre,	to seek.
sīdo,	sēdi (rarely sīdi),	—	sidĕre,	to sit down.
sterto,	stertui,	—	stertĕre,	to snore.
fīdo,	fīsus sum,	—	fīdĕre,	to trust.

Verbs the stems of which end in **l, m, n.**

(1) Perfect—**ui.** Supine—**ĭtum** or **tum.**

ălo,	ălui,	ălĭtum or altum,	ălĕre,	to nourish.
cŏlo,	cŏlui,	cultum,	cŏlĕre,	to till.
consŭlo,	-sŭlui,	-sultum,	-sŭlĕre,	to consult.
mŏlo,	mŏlui,	mŏlĭtum,	mŏlĕre,	to grind.
occŭlo,	occŭlui,	occultum,	occŭlĕre,	to conceal.
vŏlo,	vŏlui,	——	velle,	to wish.
frĕmo,	frĕmui,	frĕmĭtum,	frĕmĕre,	to roar.
gĕmo,	gĕmui,	gĕmĭtum,	gĕmĕre,	to groan.
trĕmo,	trĕmui,	——	trĕmĕre,	to tremble.
vŏmo,	vŏmui,	vŏmĭtum,	vŏmĕre,	to vomit.
gigno,	gĕnui,	gĕnĭtum,	gignĕre,	to produce.

(2) Perfect with reduplication.

fallo,	fĕfelli,	falsum,	fallĕre,	to deceive.
pello,	pĕpŭli,	pulsum,	pellĕre,	to drive.
căno,	cĕcĭni,	cantum,	cănĕre,	to sing.

(3) Perfect—**i.** Supine—**tum.**

cōmo,	compsi,	comptum,	cōmĕre,	to adorn.
dēmo,	dempsi,	demptum,	dēmĕre,	to draw away.
prōmo,	prompsi,	promptum,	prōmĕre,	to draw forth.
sūmo,	sumpsi,	sumptum,	sūmĕre,	to take up.
tĕmno,	tempsi,	temptum,	temnĕre,	to despise.

(4) Other forms.

percello,	-cŭli,	-culsum,	-cellĕre,	to strike down.
vello,	velli,	vulsum,	vellĕre,	to pluck.
tollo,	sustŭli,	sublātum,	tollĕre,	to raise up.
ĕmo,	ēmi,	emptum,	ĕmĕre,	to take or buy.
prĕmo,	pressi,	pressum,	prĕmĕre,	to press, & compounds.
lĭno,	lēvi,	lĭtum,	lĭnĕre,	to smear.
sĭno,	sīvi,	sĭtum,	sĭnĕre,	to permit.

Verbs the stems of which end in **r.**

cerno,	crēvi,	crētum,	cernĕre,	to sift, to divide.
sperno,	sprēvi,	sprētum,	sperněre,	to despise.
sterno,	strāvi,	strātum,	sternĕre,	to strew.
gĕro,	gessi,	gestum,	gĕrĕre,	to carry or bear.
ūro,	ussi,	ustum,	ūrĕre,	to burn.
curro,	cŭcurri,	cursum,	currĕre,	to run.
fĕro,	tŭli,	lātum,	ferre,	to bear, carry, or endure.
quæro,	quæsīvi,	quæsītum,	quærĕre,	to seek.
sĕro,	sĕrui,	sertum,	sĕrĕre,	to put in rows, to plait.

sĕro,	sĕvi,	sătum,	sĕrĕre, to sow.
tĕro,	trīvi,	trītum,	tĕrĕre, to rub, or wear away, and compounds, as pertero, to spend.
verro,	verri,	versum,	verrĕre, to sweep.

Verbs the stems of which end in **s**, **x**.

depso,	depsui,	depstum,	depsĕre, to knead.
pinso,	pinsui and pinsi,	pinsĭtum and pinsum,	pinsĕre, to pound.
vīso,	vīsi	—	vīsĕre; to visit or go to see.
pōno,	pŏsui,	pŏsĭtum,	pōnĕre, to place.
arcesso,	-cessīvi,	-cessītum,	-cessĕre, to send for.
căpesso,	-pessīvi,	-pessītum,	-pessĕre, to take in hand.
făcesso,	-cessi,	-cessītum,	-cessĕre, to make, to cause.
lăcesso,	-cessīvi,	-cessītum,	-cessĕre, to provoke.

Verbs the stems of which end in **u**, **v**.

Perfect—**i**. Supine—**tum**.

ăcuo,	ăcui,	ăcūtum,	ăcuĕre, to sharpen.
arguo,	argui,	argūtum,	arguĕre, to prove.
imbuo,	imbui,	imbūtum,	imbuĕre, to soak or imbue.
induo,	indui,	indūtum,	induĕre, to put on.
exuo,	exui,	exūtum,	exuĕre, to put off.
mĭnuo,	mĭnui,	mĭnūtum,	mĭnuĕre, to lessen.
rŭo,	rui,	rŭtum,	ruĕre, to rush (fut. participle ruĭturus).
spuo,	spui,	spūtum,	spuĕre, to spit.
stătuo,	stătui,	stătūtum,	stătuĕre, to set up.
suo,	sui,	sūtum,	suĕre, to sew.
trĭbuo,	trĭbui,	trĭbūtum,	trĭbuĕre, to distribute.
lăvo,	lāvi,	lautum, lōtum,	lăvĕre, to wash.
solvo,	solvi,	sŏlūtum,	solvĕre, to loosen, and compounds.
volvo,	volvi,	vŏlūtum,	volvĕre, to roll.

In the fourth conjugation the perfect is regularly formed in *īvi*, and the supine in *ītum*, as *audio, audīvi, audītum*; but the following are irregular formations :—

aperio,	aperui,	apertum,	to open.
salio,	salui,	(sultum),	to leap.
sepelio,	sepelivi,	sepultum,	to bury.
eo,	īvi or ĭi,	ĭtum,	to go.

si, tum.

fulcio,	fulsi,	fultum,	to prop.
sancio,	sanxi,	sanctum,	to consecrate.
vincio,	vinxi,	vinctum,	to bind.
haurio,	hausi,	haustum,	to drain.
sentio,	sensi,	sensum,	to feel.
farcio,	farci,	fartum,	to stuff.

i, tum.

comperio,	comperi,	compertum,	to find.
reperio,	reperi,	repertum,	to discover.
venio,	veni,	ventum,	to come.

Self-Examination Questions and Exercises.

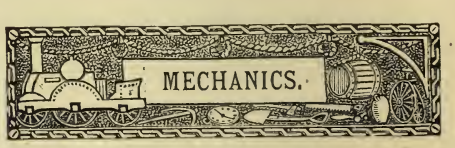
What are the regular rules in the third and fourth conjugations for the formation of the perfects and supines? Write out the main exceptions in the fourth conjugation. Give the perfects and supines of the following verbs, and account for them :—*cingo, frango, tango, colo, claudo, scindo*, and *pono*. Distinguish the verbs *edo*, to eat, and *edo*, to put forth, *sero*, to sow, and *sero*, to join, in their perfects and supines.

Translate into English :—

Coronas graminas puellæ seruissent. Quantum tempores omnes nos contrivimus ! Patres senatûs has leges beneficentissimas sanxirant. Gravi manu portas ultimas urbis tutuderat. Nonne cinxerunt urbem vallo et muro lapideo? Has arbores non modo tetigit, verum etiam fregit. Per portas apertas hostes exercitum duxerat. Hoc est facile dictu, non actu. Ne angues milites momorderint, tu vide. In medio monte exercitus hostium steterant. Quis artes pacis et belli dignissime colet? Nihil Cæsarem terruit, quin hostes victos et sparsos fugaret. Mons difficillimus est ascensu. Pueri secum multos ingentes lapides traxerant, et posuerant in summis montibus. Vinxerunt membra eorum militum, quos in prælio vicerant. Quidquid egit, id propter gloriam patriæ, non propter suam gloriam egit.

Translate into Latin :—

The shade of the trees had covered all the ground. He told many lies that he might cover her faults. The gold has been placed under the table in the house of our best friend. The horses dragged his broken body at their feet. A dark and dismal cloud had surrounded the sun, and hidden it with its shade. Tell me, if you had conquered the enemy, would you have sold them into slavery? Have these men slept whole nights under the cold sky? It is too hard to be understood. Who will worthily have sung the praises of his country? The verses of Virgil have soothed the minds of many men. What divine law has sanctioned the deeds of these citizens? or what human law has sanctioned their words or their deeds?



BY H. W. LLOYD TANNER.

I.

INTRODUCTORY.

1. We are about, reader, to make a journey in company,—a journey which, I trust, will prove pleasant and not altogether unprofitable. Part of our travels we shall perform on foot, especially in the early days of our companionship. Later on we shall, as it were, get into a train, stopping here and there at stations on our

route, but passing by whole districts with scarce a glance, and leaving others quite unseen. Should you, perchance, after our trip is done, desire to explore more thoroughly these neglected regions, you will find your trouble amply repaid. Before we start, however, I want to give you some idea of what you are about to see, and to warn you as to some of the difficulties and dangers you may encounter.

§ 2. Throw this cricket-ball into the air, and watch it as it goes. It rises higher and higher; and as it rises it goes more slowly. (This is most easily seen when the ball is thrown nearly straight up.) After a time it begins to descend; at first slowly, then faster and faster; and at last it reaches the ground. A great many questions may be put concerning this experiment. It may be asked, Where was the ball at such and such a time—say one second — after leaving your hand? How fast, and in what direction, was it moving at that moment? How high did it rise? When did it begin to fall? What was the shape of its path through the air? When and where did it meet the ground? All these are questions which a knowledge of mechanics will enable you to answer without actually trying the experiment in each particular case.

A simple experiment.

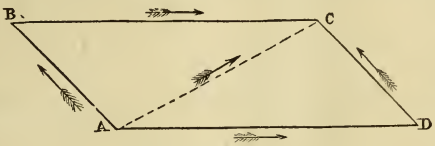


FIG. 1. (*See* p. 34.)

Again, in regarding a piece of mechanism —a crane for lifting heavy weights, a set of pulleys, or a gate, for instance—we may wish to know how strong the different parts should be, and how they may best be arranged to attain the object of the structure.

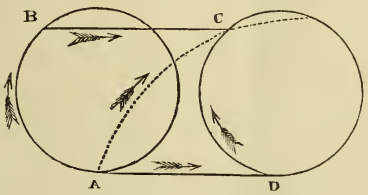


FIG. 2. (*See* p. 35.)

These are specimens—and many more might have been added—of problems, the answers to which can be found by the help of a knowledge of mechanics. Some of these questions I shall answer in the sequel; others, however, must be left unanswered, and I must be content with an endeavour to put you into a position to find out the answers for yourself.

§ 3. The second thing I have to do, before beginning our subject proper, is to warn you against certain dangers. By far the most important of these arise from the *wrong use of words*. In every-day intercourse people are very careless in using words. "It doesn't matter," they say: "everybody knows what one means;" and, as it saves the trouble of thinking, they get into a habit of saying what they don't mean, and of not saying what they do mean. This habit gives rise to another—equally bad—of reading or listening carelessly. Your hearers or readers are content with what they call a general idea of your statements; that is to say, they pay little or no attention to the qualifications and limitations—the "if's" and the "but's"—which may be the most important part of your communication. Either of these habits is incompatible with success in the study of any science. Every statement ought to be precise and accurate; and you, for your part, must make every effort to realize the idea it is intended to convey. Such efforts may at first be irksome; but by degrees they will be made almost unconsciously; and you will have acquired a habit of careful reading the value of which it would be hard to overestimate.

The right use of words.

Another very fertile source of misconception is the use of words that are ambiguous, words which may be and are understood in different senses by different persons. You must be careful not merely to have a *definite* idea corresponding to a particular word, but also that this idea is the one intended. To ensure this as far as possible, much of our early work will consist of explanations of the meanings to be attached to some words which will be frequently used afterwards. Many of these words are in common use, but it is still necessary to explain them, because in some cases the trivial meaning is not sufficiently definite, and in other cases the word really involves two or more distinct ideas. For instance, the word "weight" has at least two meanings, which in mechanical problems it is necessary to separate. Accordingly in mechanics we have two words, "weight" and "mass," which are both included in the word "weight" as popularly used; and this must be borne in mind when the word is employed. How important it is to pay attention to this matter may be inferred from the number of disputes which arise because words are employed without being explained. A very celebrated case in point is a controversy begun in 1686 by Leibnitz, continued by the greatest mathematicians of the time, and concluded, *fifty-seven years afterwards*, by a declaration of D'Alembert that it was a mere matter of words.

Just as loose and inaccurate speaking and thinking lead to misconception and confusion, so simplicity is a necessary result of precision. A statement which at first sight appears difficult to prove, which may even be hard to understand, often becomes almost self-evident when we call to mind what is meant by the individual words. It must not, indeed, be supposed that by an examination of words, no matter how searching it may be, we can gain any new knowledge; new knowledge can only be obtained from experience—that is, from experiment and observation. All that can be done by word-science or logic is the expression of our facts in new ways, so that new relations spring to light.

The secret of simplicity.

Without logic, science would be a mere catalogue of disconnected facts; without experience, words would be meaningless; with insufficient experience, our "knowledge" would be inaccurate and misleading.

Upon these points I have dwelt at some length, because I have often noticed that the difficulties of learning mechanics arise from inattention to the meanings of the words employed, and from imperfect realization of the statements made. I cannot, nor would you wish me to, save you the trouble of thinking; but I can suggest the points to which your attention should be directed; and my advice is that whenever you meet with a statement you find hard to understand, you should carefully recall to mind the explanations of the words employed. In the attempt to realize these statements you will find great help from experiment. Get a few pulleys, of different sizes, that can be attached to a board, a few "weights," and a little string; and you will have apparatus which, by a little ingenuity, can be made to illustrate much of what I shall have to tell you. By this means you will find that the study of mechanics is made thoroughly interesting, and you will, almost intuitively, discover how your knowledge may be applied in every-day life.

Hints.

Motion.

§ 4. By "motion" we understand *change of position*. If you walk from one place to another you move. Or again, if, while remaining in one place, you turn round so as to look in another direction, you move. It will thus be seen that there are two sorts of motion. In one, the thing does not move bodily, it only turns round—as, for instance, in the case of a fly-wheel upon a fixed engine. This kind of motion is called motion of rotation or turning. In the other kind of motion, the thing that moves passes from one place to another without turning round. This kind of motion is called motion of translation or passage.

Two sorts of motion.

§ 5. There are other sorts of motion, but all of these may be described by the help of the two simple motions just named. Consider, for instance, the wheel of a carriage going along a road. You would describe the motion of that wheel by saying it moves along the road, and turns round at the same time. In other words, the motion is made up of a "passage" and a "turning" movement. The motion of a spinning-top is made up of a rapid rotation, and, it may be, a passage from place to place. A billiard ball struck on one side with the cue moves in a very complicated manner; but this motion can be described by saying that it rolls and spins at the same time; so that here there are three distinct motions going on at once—a passage from place to place, and two turning motions.

Other sorts of motion.

In each of these cases the actual motion of the body is something quite different from a simple passage or a simple rotation; yet in each case it is easily and exactly described by means of these simple kinds of motion. Mathematicians are accustomed to split up a complicated motion in this way; and to consider each of the simple rotations and passages separately. If it were not for this, many mechanical problems could not be worked out. And yet the principle, so useful in the study of mechanics, is not recondite and hard to be understood: it is, on the contrary, one which, as we have just seen, is frequently employed even by those who know nothing of mechanics.

§ 6. Another method, which we shall find of great value, is closely connected with that of the last section. There we started with a complex motion and split it up into simple motions. Here, on the other hand, we shall start with two or more simple motions, and shall inquire in what position a body will be if it has all these simple motions at once. The answer is very easily given. The body will have just the same position as if it had performed the different "simple" motions one after the other.

A problem.

An example or two will perhaps help to explain this and point out the utility of the process.

A man starts from a place and moves a certain distance—let us say twenty feet—in a certain direction, say north-west. Then he moves another distance—forty feet suppose—in another direction, say towards the east. We may represent these two motions as in fig. 1. The first motion is from A to B, the second is from B to C. We may notice in passing that if he had first moved forty feet to the east (from A to D), and then twenty feet to the north-west (from D to C)—that is, if he had performed these two motions in a different order—he would still have come to the same place C. And if, instead of moving first in one direction and then in the other, he had completed both motions at once, he would still have come to the same place in the end. Suppose, for instance, he is on the deck of a vessel. If he stands still on the deck while the vessel floats forty feet to the east, he also moves forty feet to the east. If, while the vessel is at rest, he walks from one part of the deck to another, twenty feet to the north-west, then he performs the other simple motion. Now suppose that, instead of these two motions being made one after the other, they are completed at the same time; suppose that while the man is walking, the vessel floats forty feet towards the east. Then he would be moving neither to the east nor to the north-west, but in some direction between; and as a fact he would come to just the same place, C, as if he had taken his walk while the vessel was at rest, and then the vessel had moved forty feet eastward.

Another example may be taken. Suppose we make a mark upon the rim of a wheel rolling along a road, and wish to know where the mark will be after a certain time. In § 5 we saw that the motion of the rolling wheel was made up of two simple motions—a turning motion and a "passage." Now, it is easy to find where the mark will be when the wheel turns without moving along, or when

Another example.

the wheel slides along without turning; and, knowing this, we can at once find out where the mark will be when the wheel has both motions at once. Let us try. In fig. 2 the wheel is shown in two positions; and we suppose that the mark is at A when the wheel is in the first position. Now let the wheel turn round without passing along the road. Then the mark would come to B. This done, let the wheel pass along the road without turning; so that the mark passes from B to C. We know how far it is from B to C; it is the same distance as from A to B along the rim of the wheel. The same place would have been reached had the wheel first been allowed to slide without turning round, and afterwards turned round without moving along the road. In this case the mark would first have moved from A to D, and then from D to C, in the direction shown by the arrows. Now, if the wheel *rolled* along so that these two motions took place at once, the mark would move along the dotted line in fig. 2; but it would still come to the same place, C, in the end.

Although this principle is so simple, it is of the greatest use. It appears again and again under most varied forms, and its full value is only to be appreciated by one who has made considerable advance in the study of mechanics. Let it suffice for the present to commend it to your careful attention.

XXVIII.

Decimals (*continued*).

To multiply a decimal by any power of 10, we have only to shift the decimal point as many places to the right as there 0's in the given power of 10—*i.e.*, to multiply by 10 we shift the decimal point one place; to multiply by 100 we shift it two places, and so on.

This will be evident from what has already been said, and we can easily prove it in any given case.

For instance, $\cdot 76 \times 10 = 7\cdot 6$; and $\cdot 76 \times 100 = 76$; for $\cdot 76 = \frac{76}{100}$.

$\therefore \cdot 76 \times 10 = \frac{760}{100} = \frac{76}{10} = 7\cdot 6$,

and $\cdot 76 \times 100 = \frac{7600}{100} = 76$.

The same considerations will make it clear that *to divide a decimal by any power of* 10, we have only to shift the decimal point as many places to the left as there are 0's in the given power of 10, making up the required number of places by prefixing 0's to the significant figures if necessary.

Thus, $\cdot 76 \div 10 = \cdot 076$, and $\cdot 76 \div 100 = \cdot 0076$.

For $\cdot 76 \div 10 = \frac{76}{100} \times \frac{1}{10} = \frac{76}{1000} = \cdot 076$ (by the rule already given),

and $\cdot 76 \div 100 = \frac{76}{100} \times \frac{1}{100} = \frac{76}{10000} = \cdot 0076$.

Addition of Decimals.

As the decimal notation is an extension of the ordinary notation for integers, so the rules for addition and subtraction of decimals are but extensions of the corresponding rules for integers.

Rule for addition of decimals.—Write the numbers one beneath the other, so that tens are under tens, hundreds under hundreds, and so on, the decimal points thus being one under the other. Then add as in addition of integers, and place a decimal point in the sum under the other decimal points.

For instance, add together $\cdot 076$, $1\cdot 760$, $23\cdot 9136$. Write the numbers thus:—

$$\begin{array}{r} \cdot 076 \\ 1\cdot 760 \\ 23\cdot 9136 \\ \hline 25\cdot 7496 \end{array}$$

Reason for the rule.—In the ten-thousandths column we have 6, and nothing else; so we write 6 in the sum, under the ten-thousandths column. In the thousandths column we have 3 and 6, *i.e.* 9 thousandths, $\therefore$ we write 9 in this column of the sum. In the hundredths column we have 1 and 6 and 7, *i.e.* 14 hundredths, or 4 hundredths + 1 tenth. So we write down the 4 in the hundredths place and carry the 1 tenth to the next column.

We have therefore in the tenths column 1 and 9 and 7, *i.e.* 17 tenths, or 7 tenths and 1 unit; $\therefore$ put down 7 in the tenths place and carry 1 to the units.

We have now got to the units, and the rest of the addition is of integers.

It may be useful to show how this addition could have been effected by converting the given decimals into vulgar fractions, adding them as such, and then converting the answer back again to a decimal. We have

$$\begin{array}{rl} \cdot 076 = \frac{76}{1000} = \frac{760}{10000} & \\ 1\cdot 760 = 1\frac{760}{1000} = 1\frac{7600}{10000} & \\ 23\cdot 9136 = 23\frac{9136}{10000} & \\ \hline \text{Sum} = 24 + \frac{17496}{10000} & = 24 + 1\cdot 7496 \\ & = 25\cdot 7496. \end{array}$$

Exercises.

1. Find the following sums:—

(*a*) $\cdot 32 + 0\cdot 177 + \cdot 0177 + \cdot 00177$;
(*b*) $15\cdot 6 + 1\cdot 56 + \cdot 156 + \cdot 0156$;
(*c*) $7312 + \cdot 7312 + 7\cdot 312 + 73\cdot 12$;
(*d*) $1\cdot 25 + \cdot 36 + \cdot 0036 + \cdot 00009$;
(*e*) $763\cdot 01 + \cdot 54 + \cdot 307 + \cdot 0304$;
(*f*) $8654 + 35 + \cdot 33301 + \cdot 00009$;
(*g*) $\cdot 75806 + \cdot 0376 + \cdot 9$;
(*h*) $7\cdot 3682 + 16\cdot 75201 + \cdot 0009$;
(*k*) $8\cdot 756 + \cdot 88421 + \cdot 77321$;
(*l*) $6\cdot 54321 + 65\cdot 4321 + 654\cdot 321$;
(*m*) $1\cdot 0007 + 2\cdot 00001 + 3\cdot 99929$;
(*n*) $6\cdot 54321 + 654321 + \cdot 89260$;
(*o*) $5\cdot 482 + \cdot 01 + \cdot 9 + 112\cdot 001 + \cdot 006$.

2. Express as decimals, and then add together the following:—

(*a*) $\frac{15}{100} + \frac{176}{10} + \frac{19823}{100} + \frac{53}{100000} + \frac{60}{1000}$;
(*b*) $\frac{1888}{100000} + \frac{1987}{1000} + \frac{999}{10000} + \frac{4}{10000} + \frac{67}{1000} + \frac{1}{100000}$;
(*c*) $\frac{4579}{100} + \frac{86}{1000} + \frac{7732}{1000} + \frac{864}{10000} + \frac{888}{10000}$;
(*d*) $\frac{7731}{1000} + \frac{87675}{100} + \frac{324}{10000} + \frac{16}{100000}$;
(*e*) $\frac{58}{10000} + \frac{666}{1000} + \frac{3}{100} + \frac{300}{1000} + \frac{72}{100000}$;
(*f*) $\frac{9}{10} + \frac{9}{100} + \frac{9}{1000} + \frac{9}{10000} + \frac{1}{10000} + \frac{2}{100000}$.

3. Express as decimals the following, and add them together :—

(*a*) 13 hundredths + 5 thousandths + 7 ten-thousandths + 3 tenths + 35 thousandths + 19 tenths + 39 + 8 ten-thousandths.

(*b*) 17 tenths + 19 millionths + 1 ten-thousandth + 3 hundredths + 56 + 31 thousandths.

(*c*) 851 millionths + 19 millionths + 6 thousandths + 7 tenths + 16 hundredths + 83.

(*d*) 17 hundredths + 15 millionths + 1 ten-thousandth + 11 tenths + 1.

(*e*) 65 ten thousandths + 65 thousandths + 65 hundredths + 65 tenths + 65.

Answers.

1. (*a*) ·51647 ; (*b*) 17·3316 ; (*c*) 7393·1632 ; (*d*) 1·61369 ; (*e*) 763·8874 ; (*f*) 8689·3331 ; (*g*) 1·69566 ; (*h*) 24·12111 ; (*k*) 10·41342 ; (*l*) 726·29631 ; (*m*) 7 ; (*n*) 654328·43581 ; (*o*) 118·399.

2. (*a*) 216·04053 ; (*b*) 2·17311 ; (*c*) 53·7832 ; (*d*) 95·40356 ; (*e*) 1·00252 ; (*f*) 1·00002.

3. (*a*) 41·3715 ; (*b*) 57·761119 ; (*c*) 83·866870 ; (*d*) 2·270115 ; (*e*) 72·2215.

Subtraction of Decimals.

Rule.—Write the numbers to be subtracted one under the other in such a way that the decimal points shall be in the same vertical line, units under units, tens under tens, etc., and tenths under tenths, hundredths under hundredths, and so on.

Then subtract as in integers, and write the decimal point in the difference vertically under the decimal point of the numbers.

Example 1 : Subtract 3·176 from 15·987.

$$\begin{array}{r} 15{\cdot}987 \\ 3{\cdot}176 \\ \hline 12{\cdot}811 \end{array}$$

The reason of this rule will be evident from the considerations contained in the explanation of the rule for addition.

We can verify the correctness of the rule by fractions.

Thus, $15{\cdot}987 = 15\frac{9\,8\,7}{1\,0\,0\,0}$

$3{\cdot}176 = 3\frac{1\,7\,6}{1\,0\,0\,0}$

Difference $= 12\frac{8\,1\,1}{1\,0\,0\,0} = 12{\cdot}811$

Example 2 : From 1·076 subtract ·88832.

$$\begin{array}{r} 1{\cdot}07600 \\ {\cdot}88832 \\ \hline {\cdot}18768 \end{array}$$

Here we write two 0's to the right of the upper number, so that it may have as many decimal places as the lower. This, as we saw, does not alter the value of the decimal, and simply serves to show us what the 2 and the 3 in the lower are to be subtracted from.

We need not generally write these 0's; it is sufficient to *suppose* them written.

Example 3: Find the value of

21·372 − (·017 − ·132 + 13·72 − ·15).

We must first find the value of the quantity inside the bracket, and subtract it from 21·372.

Now, ·017 − ·132 + 13·72 − ·15

= ·017 + 13·72 − (·132 + ·15)

$$\begin{array}{rr} {\cdot}017 & {\cdot}132 \\ 13{\cdot}72 & {\cdot}15 \\ \hline 13{\cdot}737 & {\cdot}282 \\ {\cdot}282 & \end{array}$$

13·455 by subtraction.

Now we have to subtract this from 21·372.

$$\begin{array}{r} 21{\cdot}372 \\ 13{\cdot}455 \\ \hline 7{\cdot}917 \end{array}$$ Ans.

Exercises.

1. Find the difference between

(*a*) 16·024 and 15·932	(*f*) 2·768 and 5·0831
(*b*) 171·119 and ·6537	(*g*) 11 and 17·32
(*c*) ·7862 and ·01010	(*h*) 15·777 and 1·576
(*d*) ·0321 and ·0001	(*k*) ·00111 and ·0009
(*e*) ·1009 and ·3018	(*l*) ·637 and 1·0008

2. In each of the above exercises convert the decimal into a vulgar fraction, subtract the less from the greater by the rule for subtraction of fractions, and convert the result back again to decimals.

3. A man leaves by will to five different charities the following portions of his property : to the first ·1 ; to the second ·09; to the others ·08, ·07, and ·06 respectively. How much will remain for his family?

4. Calculate the following :—

(*a*) ·701 + ·009 − 1·777 − 13·01 + 150.

(*b*) 1·779 + ·0706 − ·002 − ·0205.

(*c*) − 16·5 − ·061 − ·00001 + 17.

(*d*) 14 − (·762 + ·305 − ·9 + 1) − ·06.

(*e*) ·78 − (·81 + ·36 − ·52) − ·3 + 105.

(*f*) ·361 − ·208 + ·543 − ·335.

(*g*) 17·361 − (5·7 + 7·5 − ·6) + (·6 − ·5).

Answers.

1. (*a*) ·092 ; (*b*) 170·4653 ; (*c*) ·7761 ; (*d*) ·032 ; (*e*) ·2009 ; (*f*) 2·3151 ; (*g*) 6·32 ; (*h*) 14·201 ; (*k*) ·00021 ; (*l*) ·3638.

2. Same as in 1.

3. ·6.

4. (*a*) 135·923 ; (*b*) 1·8271 ; (*c*) ·43899 ; (*d*) 12·773 ; (*e*) 104·83 ; (*f*) ·361 ; (*g*) 4·861.

XXVIII.

The Emperor Charles V.'s Successors and the Thirty Years' War (*continued*).

The death of Rudolf, in 1612, made Matthias emperor in name, as he had long been in fact. He lacked the firmness and skill to rule the territories he had gained; and, as he was childless, he nominated his cousin, Ferdinand of Steyermark, as his heir in Austria, Bohemia, and Hungary. The Jesuit party rejoiced openly at the prospect of the rule

The Emperor Matthias, 1612–1619.

of a man who had declared his intention to extirpate Protestantism, and boldly counselled the repudiation of old engagements towards the evangelicals, adopting the motto, "Novus rex, nova lex." The Protestants were harassed with continual attacks on their safety and privileges; and at length, in 1618, two churches, erected by the Protestants at Braunau and Clostergrab, were pulled down, on the pretext that the "Letter of Majesty" only allowed freedom of religion to the gentry. An appeal of the injured party to the emperor was contemptuously dismissed. Then the Protestant representatives in the Bohemian Parliament committed an act of overt rebellion. They appeared armed at the assembly in the palace of the Ratchin, in Prague, forcibly seized the two imperial councillors, Martinitz and Slawata, and absolutely threw them out of the window of the council hall into the courtyard below; their secretary, Fabricius, being flung down after his masters. Count Matthias Thurn, who gained a sinister celebrity in the subsequent events, was the instigator of this outrage, which marks the commencement of that great struggle which entirely changed the constitution and government of Germany, substituting misery for prosperity, and tyranny for independence—the "Thirty Years' War."

Commencement of the "Thirty Years' War," 1618.

GENERAL TILLY.

For the utraquist deputies of Bohemia felt that they had gone too far to look for pardon. They consequently drew the sword against the house of Hapsburg, and cast away the scabbard. They threw off their allegiance to the emperor, drove the Jesuits from the country, took the government into their own hands, and prepared an army under the direction of Thurn. Weak, alarmed, and taken by surprise, the aged emperor would have tried conciliation; but Ferdinand, supported by the Jesuit party, who looked forward with confidence to the issue of an armed struggle, sent imperial troops into Bohemia. Thus began the Bohemian war, the first part of the great contest of thirty years. Thurn's party quickly gathered strength; Moravia rallied to his banner, and Count Ernest of Mansfeld, a brave and experienced partisan warrior, joined the Protestants, and proved a most valuable ally.

Thurn and Mansfeld.

He drove back the imperial troops, and entered Brunn, the capital of Moravia, in triumph. Matthias' death, hastened by grief and disappointment, occurred at this juncture; and Thurn actually threatened Vienna with his troops, but was compelled to retreat for want of money and provisions. At Frankfort, Ferdinand of Steyermark was soon after chosen emperor; whereupon the Bohemians declared him deposed; and, arrogating to themselves an old right of election, of which they had been deprived after the battle of Mühlberg, they chose as their king Frederick the Fifth, the young Count Palatine, the husband of the English princess Elizabeth, the daughter of James I. Frederick wasted his time in useless pageants at Prague; and, moreover, offended the Lutheran and reformed party by encouraging Calvinistic excesses in the way of image-breaking and church desecration. Ferdinand, on the other hand, allied himself with the powerful Catholic League, and its chief, Maximilian of Bavaria. The Protestant Union, and even the Lutheran elector, John George of Saxony, were induced to keep aloof from the new king of Bohemia, who had on his side Matthias Thurn and Bethlen Gabor (Gabriel Bethlen), prince of Siebenbürgen, an astute and ambitious ruler. The greatest acquisition made by Ferdinand was in the leader of his army, John Tzerklaes, Count Tilly, a veteran commander of tried ability. The first great battle of the Thirty Years' War was that of the "White Mountain," fought on the 7th of November, 1620. The defeat of Thurn and the duke of Anhalt, who led the troops of Frederick, was complete. Superiority of numbers and the generalship of Tilly decided the fate of Bohemia on that disastrous day. Frederick fled from his capital to Breslau, Berlin, and the Netherlands, leaving for ever the country he had not the spirit to maintain. The unhappy "winter king" was remembered with bitterness and scorn by his Bohemian subjects; and an imperial sentence of outlawry soon deprived him of his hereditary dominions. The humiliation of Bohemia was complete. The emperor is said to have destroyed the "Charter of Majesty" with his

Frederick, King of Bohemia.

Battle of the "White Mountain," Nov. 7, 1620.

own hands. Twenty-seven of the principal Protestant nobles perished on the scaffold. With treachery worthy of an Eastern despot, Ferdinand, who at first affected to pursue a policy of conciliation, and thus emboldened many fugitives to return to Bohemia in the confident expectation of amnesty, suddenly let loose all the horrors of vengeance on the unhappy country. Numbers of men of importance were punished by entire confiscation of their property. Father Lamormain, or Lämmermann, the Jesuit confessor of the emperor, received an enormous share of the plunder for distribution among his confraternity. Thirty thousand families were compelled to emigrate; and the utraquists, who had so long defied the sword of the empire, found in the arts of the never-sleeping society of Jesus a more persistent and a more formidable foe. From Bohemia, the cradle of the Reformation in Continental Europe, all religious and political freedom was banished, from the day of the miserable defeat at the "White Mountain." The Protestant Union was soon afterwards dissolved, and the triumph of Ferdinand over his enemies seemed complete.

Degradation of Bohemia.

But the emperor now committed the error he repeated on several occasions during his subsequent career, and each time with disastrous consequences to himself. He miscalculated the extent of his triumph, and by attempting too much, rekindled the flame of war. He made no secret of his intention to win supremacy for the Catholic faith once more in Germany. He outlawed several German princes without observing the legal forms prescribed by immemorial usage. He sent Tilly, the chief general of the League, into the Palatinate to carry out the sentence against the ruler of that unhappy territory with fire and sword; and thus raised against his throne and his faith the resistance of desperation. Three remarkable men—the adventurous Duke Christian of Brunswick, the pious Margrave George Frederick of Baden-Durlach, and Ernest Count Mansfeld, the greatest partisan chief of the time—rose up to defend the Protestant cause. Christian of Brunswick, who called himself "God's friend and every priest's enemy," entered Westphalia with a hired army, and exercised vengeance upon abbeys and convents for the wrongs of his relative, the exiled queen of Bohemia, Elizabeth. Mansfeld contrived to raise a force of 20,000 men, and soon became so formidable that the exiled Elector Palatine ventured to return to his country under the protection of this formidable ally. George Frederick of Baden formed a junction with Mansfeld, and defeated Tilly and the army of the League at Wiesloch. But they unfortunately divided their forces, and George Frederick was defeated at Wimpfen, and only escaped capture by the self-devotion of a regiment of 400 men of Pforzheim, who sacrificed themselves for him with a heroism worthy of Thermopylæ; and Christian of Brunswick's defeat by the veteran troops of Tilly at Höchst, and the still more disastrous day of Stadtlohn appeared to destroy the last hopes of the Protestants. Christian of Brunswick and Mansfeld were obliged to fly from Germany. Frederick had already betaken himself to Holland, where he lived precariously enough for many years. He had lost the confidence of all his friends; and his father-in-law, King James of England, as Harte quaintly informs us, "supplied him only with peaceable advice and scholastic quotations, instead of money and legions." Ferdinand was now secure in his triumph; and hastened to revenge himself on those who had dared to defy his authority. The territories of the Elector Palatine were bestowed on Maximilian of Bavaria; and persecution of the Protestants in the Austrian dominions, in the archbishopric of Mayence, and in other parts of Germany, testified to the intention of the emperor to establish rigid uniformity of faith throughout the whole of his dominions.

Tyranny of Ferdinand II.

Battles of Wiesloch and Wimpfen.

FRIENDS, AND HOW TO CHOOSE THEM.

Few circumstances have a more important influence upon the success of a career than the company which is kept and the friendships which are formed. From the earliest days of school-life to the closing scene of our existence character is being shaped and moulded by the influences which surround us; and this process is most active just when the youth makes his entrance into the busy world, fresh from home and early associations, eager to secure to himself a host of friends. That "you may know a man's character by the company which he keeps," is a saying as truthful as it is ancient, and it is therefore essential that a wise choice of friends and companions should be made in early life. The student at college, the apprentice in the workshop, and the young man in business, are thrown amongst associates of varying mental and moral characteristics, and there is a danger that upon their first entry into life they may yield only too readily to influences which tend to produce habits and modes of thought the reverse of desirable. In order to counteract this natural tendency, nothing can be more effective than a firm friendship with one capable of affording sympathy, support, and guidance in the mazy path which a youth is called upon to tread. A true and judicious friend is to such a youth a veritable sheet-anchor, which often effectually prevents the goodly vessel from drifting on the numerous hidden rocks which lie ahead.

It is matter of regret that so few parents, and especially fathers, succeed in making friends of their children. Although justly re-

garded with affection, and even with reverence, a father is in too many cases looked upon by his sons as the last person in the world to whom they would confide their thoughts, or from whom they would expect sympathy and guidance in days of difficulty and doubt. Yet, in the rare cases where there is perfect confidence between a father and his sons, how valuable the guidance which his ripe experience can afford them—how many the pitfalls he may enable them to escape!

But even where a true friendship exists between a young man and his father, there is always a desire for some congenial companion of about his own age, to whom his inmost thoughts may be communicated, and with whom pleasures and sorrows may alike be shared. No mistake is more unfortunate than that of supposing that a number of intimate companions preclude the necessity or supply the want of a bosom friend. Companionship with a select few is a necessity, and if the companions be judiciously chosen, a great benefit; but nothing can efficiently supply the want of some intimate friend who can afford that true and brotherly sympathy which only one who is but little less than part of one's self can possibly supply. Nature, with her characteristic adaptation of means to ends, has implanted within us desires which lead us to satisfy this want of our moral nature; and we instinctively form a close friendship in the very morning of our existence.

But very early friendships seldom last throughout life, and it is usually necessary to select a fresh confidant from our companions at a time when we are enabled to exercise some judgment in the choice, and are not so completely at the mercy of circumstances as is the case in childhood. But unfortunately there are friends and friends, and it is necessary to bear in mind the tests by which we may distinguish false from true.

The first great requisite in a friend is sincerity, and this necessarily includes uprightness and truthfulness both in word and deed. Never were truer words penned, even by the great dramatist himself, than those which he puts into the mouth of Polonius:

> "To thine own self be true;
> And it must follow, as the night the day,
> Thou canst not then be false to any man."

And the converse of this aphorism is also true—namely, that the man who is thoroughly sincere is incapable of baseness even to an enemy. In making a friend it is therefore of the first moment to thoroughly assure ourselves of his sincerity, and at the same time to carefully watch our own heart and see that that too is true to our chosen friend.

Another important requisite in a friend is complete candour. He is undoubtedly the truest friend who has the courage to tell us gently, though firmly, of our faults and shortcomings. Without captious fault-finding, he should point out errors of judgment, of speech, and of action, and should be willing to help us to become better and wiser. But to do this he must possess the requisite qualifications; and it is therefore wise to select as a friend one upon whose judgment we can implicitly rely and in whose thorough honesty we can place unbounded trust. As a general rule, it is better for a young man to select as a friend one somewhat older and more experienced than himself, but this depends very largely upon natural disposition. Some natures are strong and self-reliant, others soft and yielding, and therefore needful of support; each must choose for himself the most suitable companion in this respect, and inclination when controlled by judgment is usually a reliable guide.

As a general rule, to which there are but few exceptions, it is a great mistake to choose a friend from those whose position in life widely differs from our own. If the station occupied by an intimate friend be much higher than one's own, expenses are likely to be incurred unsuited to one's pocket, and habits may be acquired unsuitable to one's own position, and therefore undesirable. If these habits and expenses be successfully guarded against, there is an uncomfortable feeling of inferiority which interferes greatly with that close intimacy which is an essential in true friendship. On the other hand, it is a still worse error to choose an intimate friend from those in a much inferior position in life, unless, as very rarely happens, the favoured individual be above the average of his class in tastes, habits and acquirements. It is a common error to suppose that we can raise an intimate friend to our own level. This does sometimes happen, but it is the exception rather than the rule, and is in nearly every case a very hazardous experiment. It is much more likely that the superior mind will descend to the level of the inferior than that the reverse will happen. We must, however, ask our readers to thoroughly understand that we by no means intend to imply that the class or caste-feeling should be greatly considered in the formation of a friendship. The thoroughly honest, upright man of refinement and culture is worthy the friendship of a prince, though he belong to the lowest rank in society; but unless he be all this it would be unwise for one in a high position to cultivate his acquaintance on the footing of an intimate friend. It is often right and necessary to associate with those occupying an inferior station in society to ourselves, but it does not necessarily follow that we are to choose from such our bosom friend.

A very desirable condition of a friendship is a tolerable similarity of tastes. That some of the most enduring friendships have subsisted between persons of very different tastes it is impossible to deny, but as a general rule persons of completely opposite likings are not suitable for companions, and still less for intimate friends. If, for instance, a young man of studious habits, and having a disinclination to the more exciting forms of recreation, ally himself in close friendship with one to whom books are a bugbear, and who takes delight in the most exciting relaxations, the friendship is not generally either a beneficial or a lasting one. Contrasts in character frequently blend beautifully together; opposed tastes and inclinations rarely or never. The

same qualifications which are required in a confidential friend are to a less extent necessary in our acquaintances. Almost every one has an inner circle of select friends in whose company he delights to spend his leisure hours; and if this inner circle be composed of men of high moral tone and of pure tastes, it matters but little what may be the general character of those with whom we may at other times be compelled to associate. In choosing those friends who, though intimate with us, are not bosom friends, it is wise to see that they are above all things else pure in life and character, if we desire to be so ourselves. No one can "touch pitch and not be defiled." However we may pride ourselves upon being able to resist temptation, we cannot possibly avoid contamination if we breathe a polluted moral atmosphere. Whatever opinions may be held upon matters theological, it is clear to every one who thinks for himself that we cannot set before us too high an ideal of moral beauty and perfection. Without some such ideal, no man, or body of men, can possibly come to much good; and if we would possess such an ideal we must associate with those whose moral standard is at least as high as our own.

Finally, we would impress upon our readers the absolute necessity of thorough loyalty towards the friends whom they have deliberately chosen. Be careful never to wrong a friend even by a thought, and above all avoid saying anything behind their backs which you would not care to say before their faces. If you have any cause of complaint, real or imaginary, go to your friend and tell him candidly about it, and in this way much misunderstanding may be entirely avoided. The man who keeps a supposed grievance against a friend rankling in his own breast is a traitor to his bond of friendship, and possibly a needless disturber of his own serenity.

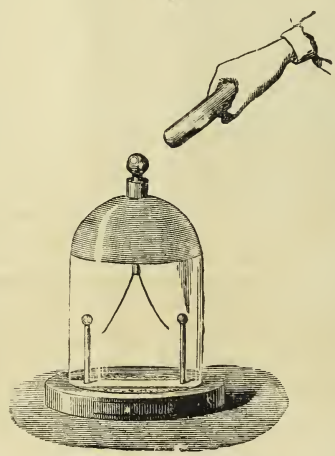


FIG. 5.—THE ELECTROSCOPE.

II.

FRICTIONAL ELECTRICITY (*continued*).

THE facts stated in our last article may be proved in a variety of ways. For instance, we may electrify a stick of sealing-wax and suspend it by placing it in a small wire stirrup, hung from some support by silk tape. Then if we bring another excited stick of sealing-wax near it, we shall find that the suspended one will be repelled, while, if an excited glass rod be brought near, the suspended wax will be powerfully attracted.

Further experiments.

Again, if we electrify a sheet of warm brown paper by rubbing it with the hand or with a brush, and then with a sharp knife cut it into strips, it will be found, on lifting the strips from the table, that they will diverge from each other, being, of course, similarly electrified. In the same way an electrified sheet of foreign letter-paper may be cut into strips and made to form a divergent tassel.

These experiments naturally lead us to our second generalization, which is that *there are two kinds of electricity—one similar to that generated on glass by friction with silk, the other like that developed on sealing-wax by friction with flannel—and each electricity repels its own kind and attracts the opposite kind.* In other words, *bodies similarly electrified repel each other, bodies oppositely electrified attract each other.*

Second generalization.

To this we may add that it is generally said that bodies which exhibit no electrical excitement possess equal quantities of the two kinds of electricity, which are mingled together so as to neutralize each other, while, by rubbing, this equilibrium is disturbed by the separation of the two electricities, one going to the rubber, the other to the substance rubbed.

At one time it was usual to call the electricity developed on glass by friction with silk *vitreous* electricity, and that developed on wax by friction with flannel *resinous* electricity; but these terms are now disused, as it is found that the nature of the electricity produced on any substance depends upon the material with which it is rubbed, and also upon other conditions, such as temperature, etc. We may, for instance, get from glass the same electricity as we do from wax, if the glass be ground and rubbed with flannel instead of silk; or even by holding an ordinary glass tube in an alcohol flame it becomes negatively electrified.

Vitreous and resinous electricities.

It is therefore usual to employ instead of *vitreous* the term *positive*, and instead of *resinous* the term *negative*; the former usually being denoted by the sign + (*plus*), and the latter being usually denoted by the sign — (*minus*). In this signification we shall use these signs and terms throughout these lessons.

Use of the terms positive and negative.

In the following list, if any two of the substances named be rubbed together, the one nearest the top of the list will be found positive to the one below it. Thus, if glass be rubbed with silk the glass will be positive and the silk

negative; if gutta-percha be rubbed with fur, the latter will be positive, the former negative. This list must be taken, however, as only approximately correct.

+	+
Fur	— Cotton
Flannel	Silk
Ivory	The hand
Quartz	Sulphur
Wood	Vulcanized caoutchouc
Shell-lac	Ebonite
Resin	Caoutchouc
Metals	Gutta-percha
Glass	— Gun-cotton (collodion)

Theoretical explanation of the foregoing facts.

With regard to the theory of electricity, no thoroughly satisfactory explanation of electrical phenomena has yet been given, but it is usual to adopt the so-called "two-fluid theory" which is embodied in our second general statement. It must, however, be thoroughly understood that this theory or hypothesis is rather an *expression* than an *explanation* of the phenomena of electricity, and must by no means be regarded as a final and thoroughly satisfactory solution of their various features, but rather should be looked upon as an hypothesis which is temporarily made use of until some more comprehensive and trustworthy theory shall take its place.

For the further elucidation of the elementary facts of electricity it will be necessary for our readers to construct two more pieces of simple apparatus: the first of these is what is called a *proof plane*, the second is known as a *gold-leaf electroscope*.

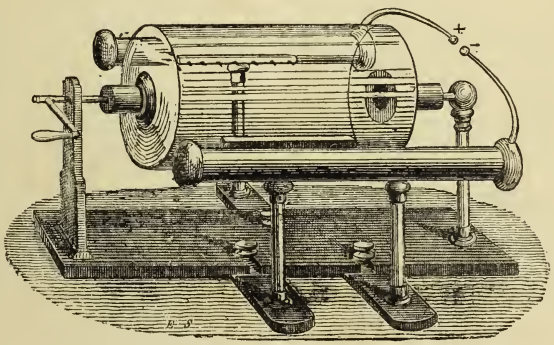


FIG. 6.—TRAUNE'S MACHINE.

How to make a proof-plane.

The best way to make a proof plane is to get an ebonite penholder (or a piece of flat varnished glass), and attach to it with shell-lac a circular or elliptic disc of cardboard covered with metallic paper, as in our illustration (fig. 7).

How to use the proof-plane.

The use of the proof plane is to take, as it were, samples of electricity from an electrified body, and convey them to the electroscope for examination, in order that we may determine the kind of electricity with which a body is charged. The metallic paper with which the disc is covered, being a good conductor, readily accepts electricity from any electrified body with which it may be brought in contact; and the ebonite or varnished glass handle, being a non-conductor, the electricity is unable to escape from the disc, and we are thus enabled to convey it to the electroscope for examination.

How to construct an electroscope.

The construction of a gold-leaf electroscope is a somewhat longer process, but is nevertheless simple and the materials inexpensive. For it we require a large glass flask, which must be thoroughly clean and dry; a cork, through which a hole must be bored, and into the hole about an inch of narrow glass tubing fitted. In addition, we shall require a straight piece of brass wire about nine inches long; a small disc of zinc or brass, from an inch to an inch and a half in diameter; and some Dutch metal or gold leaf.

Provided with these, fill the small piece of glass tube with resin or shell-lac, or with a mixture of both; then solder your metal disc to one end of the wire, making a hole in the centre of the disc in which to fix the wire. Having done this, warm the wire and push it through the resin in the glass tube of the cork of the flask, leaving some two or three inches of the wire, and also the disc, above the cork, and therefore outside the flask. Next bend the other end of the wire into a hook, and attach with gum a leaf of Dutch metal on to each side of the hook; place the cork with the gold leaves, etc., in the flask, and your electroscope will be complete, and will resemble what is shown in fig. 5.

The cutting of the leaves of Dutch metal, and attaching them to the wire, will require some care, but the exercise of a little patience will soon overcome any temporary difficulties which may stand in the way of ultimate success. It is best to cut the Dutch metal with a large pair of shears (so as to make only one cut), holding it between tissue paper.

How to charge an electroscope.

Having constructed the electroscope, the next thing is to "charge" it—that is, to electrify the gold leaves. This may be done in one of two ways. It may be done by holding in contact with the disc an electrified body, such as excited glass or wax, or a proof plane which has been momentarily in contact with an excited body. The leaves will be seen to diverge; and by bringing a similarly electrified body to the one just used near the electroscope, the leaves will be still further repelled by each other, showing that in this case the electroscope has been charged with the same electricity as that with which the charging body was endowed.

Theoretical explanation.

The *rationale* of this method of charging an electroscope, which is known as charging it by "conduction," is as follows:—The, (we will suppose,) excited glass rod being placed in contac

with the disc of the electroscope, gives up part of its electricity, and decomposes the neutral electricity of the wire and leaves, attracting the negative towards the disc and repelling the positive into the gold leaves, which being similarly electrified repel each other and diverge. The second method of charging an electroscope is known as charging it by "in-

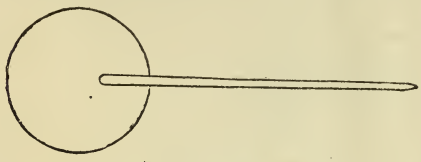


FIG. 7.—THE PROOF-PLANE.

duction." In this case the electrified glass rod is held *near, but not touching* the disc of the electroscope, when the leaves will diverge. While it is thus being held, the disc is *momentarily* touched with the finger, and *immediately* afterwards the rod is withdrawn; the leaves will then first collapse, and afterwards diverge.

The explanation of this is as follows:—When the glass rod is held near to the electroscope the positive electricity is repelled and the negative attracted by it. When the finger touches the electroscope disc the positive electricity escapes and the negative, set free by the subsequent removal of the rod, diffuses itself, and the leaves diverge with negative electricity.

HOW TO PASS EXAMINATIONS.

PART II. THE ORDEAL.

IN our first paper on examinations (see page 19) we endeavoured to point out the course to be pursued in preparing for one; and we shall now proceed to give our readers a few useful hints as to the best way of passing an examination.

Assuming that due preparation has been made, we will suppose that the student presents him or herself at the appointed day and hour for the examination. The first point to be observed is *punctuality*. Allow plenty of time for reaching the place of examination, as in this way flurry and excitement may be avoided, coolness being a very essential thing for success. Arrived in the examination room shortly before the time appointed for the commencement of the terrible ordeal, endeavour to collect your thoughts. Nervousness very heavily handicaps a candidate, and everything should be done to avoid it. Some persons are much more liable to this than others; but we would remind those who approach an examination with fear and trembling that if careful preparation has been made it is extremely unlikely that any question can be asked which they will be unable to answer; and if they feel inclined to envy the apparent coolness of other candidates, they should also remember that confidence at least as frequently arises from a superabundance of self-conceit as from a conviction of the possession of the knowledge necessary to ensure a pass. Every one who has had any experience of examinations has seen how frequently the candidates who appear most elated at the commencement are most chap-fallen at the announcement of the result. Above all, it is necessary to remember that he who conscientiously does his best can do no more, whatever may be the result, and that to fail honourably is a misfortune rather than a fault.

When the papers are given out it is well first to carefully read the instructions which are usually given at the head, as failure to fully comply with the regulations often results in rejection of competent candidates. The questions should then be carefully read through, and the candidate should divide the time allotted to the examination into as many parts as there are questions to be answered. If, for instance, three hours be the time allotted, and the number of questions to be answered be six, this will give half an hour to each one. A neglect of this precaution often results in answers of very unequal merit and completeness, and diminishes the total value of the paper. In most instances the questions may be answered in any order convenient to the candidate; and where this is the case it is generally best to answer first those questions about which the information possessed is most complete, as this gives time for more thought and care to be bestowed upon the more difficult portions of the paper.

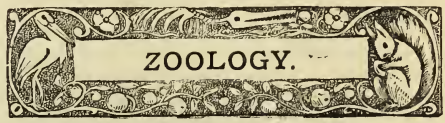
In answering a question, it is of the utmost importance to read it carefully, so as to thoroughly grasp its meaning, misapprehension of which necessarily leads to failure. A point of equal importance is to confine the answer strictly to the subject of the question. Let the answer contain all that is asked for, and no more. Much annoyance is experienced by examiners from the discursive answers which some candidates give. It is well to remember that the time of examiners is usually very valuable; and if candidates will persist in unnecessarily occupying it, they can hardly be surprised if they are made to pay a penalty in the shape of loss of marks.

Another point often overlooked by candidates is the futility of attempting to substitute knowledge of one subject for ignorance of another. Instances constantly occur where a student, being ignorant upon the point mentioned in a question, proceeds to display to the examiner his knowledge upon some other matter which he is not asked about, evidently with the fond hope of gaining credit for it. Never was a more complete delusion; the examiner requires at the hands of the candidate information upon a certain subject, and the absence of that information will be visited with certain failure, in spite of the fact that the candidate is master of all other knowledge which it is possible for him to possess.

Great care should be taken to treat in due logical succession the various points involved in a question. In describing historical events, keep as strictly as possible to their chronological order; in explaining a natural phenomenon, let each step of your explanation flow naturally from the preceding one, and beware of "putting the cart before the horse." Be careful also to show the examiner that you are acquainted with all that is involved in the question, and do not assume that he will take anything for granted. Many answers resemble too closely the replies given to a teacher personally acquainted with the student, inasmuch as they seem to assume that the examiner must be aware of the amount of knowledge possessed by the person he is examining, and is merely questioning him as a mental exercise. This common error should be carefully guarded against. Remember that the examiner is a perfect stranger, having no preconceived notions about the candidate, but judging him solely from the paper before him. That paper should therefore be as clear and as free from ambiguity as possible, and a complete compendium of the candidate's knowledge upon the subjects treated of.

Legible writing is of considerable importance, as it saves the examiner much annoyance, and the candidate from the risk of losing marks through a misapprehension. It is advisable also to refrain from the use of unnecessarily long or technical words. As a general rule, the answers which contain most technical terms and the longest words, display the most ignorance. Students utterly unacquainted with the elements of scientific knowledge frequently discourse, as they think, most learnedly concerning "luminiferous ether," "incandescence," and the like, until examiners have acquired the habit of being specially on their guard in examining papers which bristle with technology.

Finally, we would commend to the notice of those of our readers who intend to sit at an examination the excellent advice given by Cicero to pleaders at the bar—namely, that it is more important to say nothing which may injure your case, than to omit something which might possibly serve it. Rather let your answer be silent upon some point referred to in the question, than add to it anything of which you are not perfectly sure. Many examiners deduct from the marks given to correct answers "minus marks" for gross blunders in other parts of the paper. There are numerous anecdotes which show how students who will "protest too much" damage an otherwise good answer. Amongst others are the following:—A candidate for admission to one of the training colleges for school mistresses was required at the Scripture examination to give a sketch of the life of St. Paul. In her answer she stated that "St. Paul was brought up at the foot of Gamaliel, *a lofty mountain in Galilee.* A male candidate at a similar examination, replying to a question upon the conversion of England to Christianity by Saint Augustine, stated that "he baptized his numerous converts upon the sea-shore, *in an iron church hastily erected for the occasion.* Had the words in italics in either of these answers been omitted, the papers would have passed muster. We would therefore advise our readers when entering for examination to keep cool, and to avoid saying too much. Some examinations require a knowledge of dates or other statistics, which most persons find extremely difficult to keep in memory. The wisdom and fairness of the examiners who expect such knowledge is very doubtful, but where statistics are required we would advise the committing of them to memory immediately before the examination; with this exception it is generally found beneficial to complete the preparation at least a day beforehand, so as to allow the mind to repose and gain strength for the final strain to which it has to be subjected.



II.

Geographical Distribution of Animals —The Struggle for Existence.

The subject of the geographical distribution of animals is one of the deepest interest in zoology. We note that each kind lives in its own territory, the boundary varying for nearly every one. We meet with facts of the most marvellous kind, such that the mind imperatively seeks for some clue to explain how they have been brought about, and we ask what keeps the areas within which animals live so well marked out, seeing that there is no visible partition to restrain them, except where sea or cliff afford impassable barriers.

Geographical provinces.

For a satisfactory knowledge of zoology we must study the nature of the mediums in which animals live, and discover the necessary characters which animals must have according as they live in earth, in air, or in water. Learning from physiology that all animals require a regular supply of oxygen, and that they have to get rid of a corresponding quantity of carbonic acid, we are prepared for a different series of adaptations of structure according as animals are always surrounded by water or air. These adaptations for breathing must affect more or less the whole structure and arrangements, especially the circulation of the blood. As the aquatic animals for the most part breathe by oxygen dissolved in water, some means must be found for causing a sufficient quantity of water to come in contact with the breathing organs, since water only dissolves a small proportion of oxygen.

Structure varying with medium.

Again, the necessity of knowing the physical nature of the surrounding medium is seen in contrasting the character of motion in water and on earth. The weight and buoyancy of water, counterbalancing a great part of the

Motion in water and on land.

weight of bodies immersed in it, makes it very much easier to move in water than in air, and thus diminishes the need for powerful and bulky muscles in aquatic creatures. This again modifies the general structure, and especially the hard parts which supply leverage for the muscles.

The lightness of air, on the contrary, makes a new set of conditions for flying animals. We have to learn the various ways in which the natural tendency of bodies to fall when set free in air can be counteracted, while yet the need of powerful muscles to produce motion is supplied; and we discover the various methods of lightening the body so as to give the extreme of buoyancy combined with power. And while there is an intense beauty in these arrangements themselves, a yet higher perfection of grace and symmetry is superadded to these in very many of the inhabitants of the air.

Motion in air.

Turn where we may, we shall find interesting relations between an animal's organization and its surroundings. The varied nature, consistency, quality of the food available, are met by corresponding structures. For hard substances we have huge grinders; if trees have to be torn from their resting-places, we find powerful limbs, which can pull down branches; if the food itself must be torn asunder, long sharp teeth are added. To catch and retain a host of small insects, the ant-eater's tongue is covered with thick sticky saliva; to entrap the flying insect, the more rapidly flying swallow can dart out its tongue with the most marvellous velocity; to ensnare the passing prey the spider can spin a web and the beetle dig a pit. The serpent is made capable of springing upon its victim without giving it the chance of escape; the whale merely opens its mouth, and a sea of swimming creatures is engulfed and captured. These are but faint indications of the great truth, that as many as are the kinds of food, and the conditions of obtaining it, so many are the special modifications and constructions found in the animal kingdom.

GRIZZLY BEAR (*Ursus ferox*) BLACK BEAR (*Ursus Americanus*).

We can now refer to another law of great moment in zoology. Do we not easily recollect the names of various animals which live almost everywhere, and of others that are only found in particular regions? The brown rat is at home anywhere when he has obtained access, and multiplies enormously. Reasons for universal distribution are to be found either in simplicity of food required, or adaptation to eat various kinds of food. Man is naturally very widely distributed on the globe, because he is able to get and eat all kinds of food; otherwise he could not have been settled at home in so many countries, before the means existed of carrying large quantities of food over great distances. But if an animal is specially suited to procure and eat some particular kind of food, its existence must be restricted to the regions where that food is to be obtained. This is one of the most potent limits to the distribution of species.

Wide distribution of some species.

But beyond this, we must consider certain physical features of the earth's surface. The same kind of food may exist on both sides of a broad river; but if an animal is unable to cross that river, it will be found only on one side. Similarly a mountain may act as an impassable barrier. The tropical parts of the globe thus constitute a separation between the northern and the southern temperate zones, giving a different aspect to the animal population. There may even be no apparent barrier that an animal cannot overstep; but if it be specially suited for forest life, for instance, it cannot get from one forest to another unless the distance is short enough to be traversed in health and safety from destruction.

Physical barriers.

Yet we find much more strange phenomena in the actual distribution of animals. In some cases there are identical animals found separated by impassable physical barriers. How can this be? We are not taking up the theory which simply says, "they were created so," and seeks no further explanation. The search after the reasons of things has ever been the antecedent to man's unlocking yet fresh secrets of nature, and proving their reality by the new combinations and inventions which are devised in consequence. We are impelled to ask, why in one part of the globe such and such a width of sea, or height of mountain, forms an insurmountable obstacle to the spread of a species, when in another locality the same species exists in abundance on both sides of a similar dividing element or region?

Peculiarities of distribution.

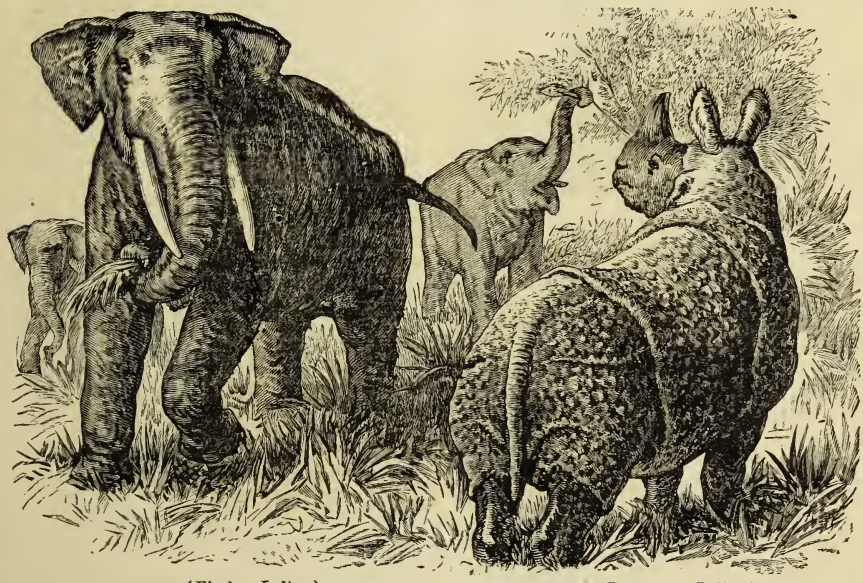
Here geology steps in and renders aid of the most valuable kind to zoology. Geology tells us of changes which have occurred in past

time in the physical geography of the earth, of forces which were competent to produce those changes, and which are still acting. We hear of seas being gradually dried, of lake basins being formed or dried up, of continents being slowly upheaved. And by many lines of evidence we are shown that barriers existed in former times which are no barriers now, and that modern times have brought forward into importance divisions which were imperceptible long ago.

Past geological causes.

Thus, when we ask the reason for the existence of the fox now, and the wild boar centuries ago, on both sides of the Straits of Dover, the geologist informs us that not so very long ago in geological time Britain formed part of the continent of Europe, and no sea separated the two. From having free access, these creatures roamed over the whole country accessible to them, and many were left in the island when it was finally cut off from the mainland. The more the student dives into the study of geographical distribution, the more interest he will find therein.

English Channel.



ELEPHANT (*Elephas Indicus*). RHINOCEROS (*Rhinoceros Indicus*).

When we approach the subjects comprehended in the phrase "struggle for existence," we come to circumstances complex in the extreme, which have the utmost influence upon the science of zoology, but which it has only been possible in recent years to begin to unravel. The key-note to the central question, however, lies in the fact that each kind of animal produces more young ones than can usually live to attain maturity; and every species, if left to multiply itself unchecked, would before many generations cover the world with its progeny. Many, no doubt, are killed by unfavourable physical conditions—excess of heat, cold, wet, or dryness. But food is limited in quantity; many animals eat the same kind of food. Those which live on similar food are competitors with one another; nay, each member of the same species is a competitor with every other in its neighbourhood, supposing the total amount of food in a particular spot is not sufficient for them all. Then the strongest or the cleverest win; those best adapted to secure food obtain it and flourish, the rest starve. Those who are strongest and best adapted to their surroundings and means of subsistence live to rear offspring; the vigour and excellence of the race is thus kept up. Viewing the species as a whole, it is a misfortune to have no competitors, to have more than enough food for all; these are not the conditions of true superiority and progress. No doubt it is for the general good that in the animal world the weakest "goes to the wall."

Struggle for existence.

Competition for same food

The number of animals is further kept down, and their quality is improved, by the direct contest of animals for food, when those of the same kind kill one another. But a far more deadly engine is the destruction of members of one species by animals of a totally different description—which may be broadly referred to as the preying of flesh-eating on herb-eating creatures. It may be doubted whether many of the grass-eaters ever die what we call a *natural* death; their natural end is a *violent* death from the blows or bites of their stronger enemies. Yet the larger and more powerful quadrupeds have not everything their own way because of their size and strength; often they find very efficient enemies in the small stinging insect, or in the worm parasite which they

Slaughter of animals.

cannot catch, but which can torment them to death. Thus we get an idea of the normal state of the animal world as one of combat and of death by violence, or by some termination other than that of old age.

We may see, too, how the whole animal creation is more or less directly dependent upon the kingdom of plants; for the flesh-eaters feed on the plant-eaters, and the latter can only live if the plants they eat are obtainable. The shelter of trees or bushes enables many a lazy freebooter to lie in wait or to spread his snares for his prey. In torrid climes the succulent plant often furnishes the fluid without which an animal would die. But the service is returned, and plants are dependent upon animals when they are entirely, or almost entirely, fertilised by their agency, when the bee carries pollen from one flower to another, and secures that intercrossing which is of vital importance to the vigour of many plants no less than animals.

Animals dependent upon plants.

XXII.

Numerical Adjectives.—Theory.

1. Names of numerals are divided into two classes—Cardinal and Ordinal.

The cardinal are those which express number only.

The ordinal denote position in a certain series.

THE CARDINAL NUMBERS.

1. Un; fem. une.	60. Soixante.
2. Deux.	61. Soixante et un.
3. Trois.	70. Soixante et dix.
4. Quatre (r. *katr'*)	71. Soixante et onze.
5. Cinq.	72. Soixante-douze.
6. Six (*siss*).	73. Soixante-treize.
7. Sept (*sett*).	74. Soixante-quatorze.
8. Huit (*uitt*).	75. Soixante-quinze.
9. Neuf.	76. Soixante-seize.
10. Dix (*diss*).	77. Soixante-dix-sept.
11. Onze.	78. Soixante-dix-huit.
12. Douze.	79. Soixante-dix-neuf.
13. Treize.	80. Quatre-vingts.
14. Quatorze (*qu=k*).	81. Quatre-vingt-un.
15. Quinze (*qu=k*).	82. Quatre-vingt-deux,etc.
16. Seize.	90. Quatre-vingt-dix.
17. Dix-sept (*di-sett*).	91. Quatre-vingt-onze, etc.
18. Dix-huit (*di-zuitt*).	100. Cent (r. *san*).
19. Dix-neuf (*di-zneuf*).	101. Cent-un, etc.
20. Vingt (*vin*).	119. Cent-dix-neuf.
21. Vingt et un (*vin-té-un*).	120. Cent vingt.
22. Vingt-deux.	200. Deux cents.
23. Vingt-trois, etc.	201. Deux cent-un.
29. Vingt-neuf (*vin-tneuf*).	1000. Mille (r. *meell*).
30. Trente.	1,000,000. Un million.
31. Trente et un.	1000 millions=*billion*,* for which, in financial statements, the term *milliard* is employed.
32. Trente-deux, etc.	
40. Quarante.	
50. Cinquante.	

Remarks on the Pronunciation of Certain Numerals.—1. When *cinq*, *sept*, *huit*, are followed by a vowel, or stand last in a sentence, the final letter is pronounced—the *p* in *sept* remaining always mute; how many are there? there are five, *combien y en a-t-il? il y en a cinq* (pr. *cinque*); 5 men, *cinq hommes* (pr. *cin-quommes*); but 5 houses, *cinq maisons* (pr. *cin*).

2 When *neuf* is final, the *f* is sounded. Preceding a vowel or *h* mute, the *f* is sounded as *v*: 9 men, *neuf hommes* (pr. *neu-vommes*). Before a consonant it is mute: 9 books, *neuf livres* (pr. *neu livres*).

3. In *six* and *dix*, the *x* remains mute before a consonant; before a vowel it takes the sound of *z*; when final it sounds as *ss*: 10 sheep, *dix moutons* (pronounced *di*); 66 men, *soixante-six hommes=si-zommes*; 70, *soixante-dix*, say *diss*.

4. The *t* in *vingt* is mute except before a vowel or in the numbers 21—29 inclusive: in those from 80 to 99 it is never sounded. By pronouncing, *e.g.*, 24 *vint-quatre*, and 84 *quatre-vin-quatre*, all chance of misunderstanding is avoided, although the first *quatre* in 84 may not have been caught by the ear.

5. *Onze* (*onzième*, etc, also included) admits of no elision in the article, preposition, or particle preceding; as, *le onze*, the 11th. However, in common conversation one may say, *Il n'en est resté qu'onze*, there only remained eleven of them. When used as a common noun, *un* likewise suffers no elision: *mettez le un avant le deux*, put the one before the two; and there is no connection in the phrase *sur le sune heure*, at about 1 o'clock.

2. Hints on the Usage of Certain Numerals.

a. Un is the only one which has a feminine form. It is employed also as a *qualificative* adjective: *il faut que dans un poème l'action soit une*, in a poem the action must be one.

b. The series from 70 to 99 is anomalous in its nomenclature. In Belgium, Switzerland, and some parts of France, the forms *septante*, (70), *octante* (80), *nonante* (90), are in use. In spite of its wisdom, this practice is not generally admitted. The use of *vingt* (as in *quatre-vingts*), which is a trace of Celtic influence, resembles that of score in English. *Les Quinze-Vingts* (300) is an hospital in Paris, founded by St. Louis IX. When a single inmate is spoken of, *un Quinze-Vingt* is used. The form *six vingts* is also found in the writers of the seventeenth century: *Vous passerez les six vingts* (Molière), you will live over six score years.

c. Vingt and *cent* are the only cardinal numbers capable of taking the sign of the plural. When *vingt* and *cent* are multiplied by another number which precedes them, they take *s;* but they remain unaltered if another number follows, or if they are used for the corresponding ordinals.

Quatre-vingts fantassins, 80 *foot-soldiers.*
Trois cents cavaliers, 300 *horsemen.*
Quatre-vingt-trois marins, 83 *sailors.*
Trois cent-un artilleurs, 301 *artillery-men.*
La page quatre-vingt, *the* 80th *page.*
L'an sept cent, *the year* 700.

d. For 61 and 70, either *soixante et un*, or *soixante-un*, *soixante et dix*, or *soixante-dix*, may be used, but the Academy prefer the insertion of *et* in both cases; 81 and 91 have no *et*, nor is *et* inserted between hundreds and teens as in English: hundred and twelve=*cent-douze.*

e. Mille is always invariable: as *trois mille prisonniers*, 3000 prisoners. In stating dates the form *mil* is used: *L'Empire d'Orient tomba en mil quatre cent cinquante-trois*, the Eastern Empire fell in 1453. But, *L'Empire d'Orient tomba mille quatre cent cinquante-trois ans après Jésus-Christ*, the Eastern Empire fell 1453 years after Christ. In the first case *mil* is an ordinal, a particular year being meant;

* Whereas the French billion=1,000,000,000, the English and German=1,000,000,000,000.

in the second *mille* is a cardinal marking a number of years. *A thousand* is read *mille*, not *un mille*; this applies also to *a hundred*, which is called *cent*.

Mille, the substantive, means a mile: as, *Le cheval fait tant de milles par heure*, the horse makes so many miles an hour.

f. Instead of *mille cent*, 1100, *onze cents* may be used; and so on up to 1900, *dix-neuf cents*. Whatever the size of the number may be, it can never be cut up into sections as in colloquial English: What is the number of that picture?—It is 5, 3, 4 (or 5, 34) = *quel est le numéro de ce tableau?—c'est cinq cent trente-quatre*; never *cinq, trois, quatre!*

3. PRELIMINARY NOTIONS ON THE VERB.—REGULAR VERBS are those which follow the rules of formation given as under.

a. From five simple parts of the verb, all others may be formed; for this reason they are called primitive forms or tenses, namely:—

The Present Infinitive. The Past Participle. The Present Participle. The Present Indicative. The Perfect Definite.

b. Form of the Primitive Parts of the Four Conjugations.

Pres. Infin.	Pres. Part.	Past. Part.
1. *parl-er.*	*parl-ant.*	*parl-é.*
2. *fin-ir.*	*fin-issant.*	*fin-i.*
3. *recev-oir.*	*recev-ant.*	*reç-u.*
4. *vend-re.*	*vend-ant.*	*vend-u.*

	Pres. Indic.	Perf. Def.
1.	*parl-e.*	*parl-ai.*
2.	*fin-is.*	*fin-is.*
3.	*reç-ois.*	*reç-us.*
4.	*vend-s.*	*vend-is.*

c. The Present Infinitive forms Two Tenses:

1st, The Future, by the change of *r, r, oir, re*, into *rai, ras, ra, rons, rez, ront.**

2nd, The Present Conditional, by the change of *r, r, oir, re*, into *rais, rais, rait, rions, riez, raient.*

d. The Present Participle forms Three Tenses:

1st, The three persons plural of the Present Indicative by the change of *ant* into *ons, ez, ent*, except the third conj., which, in the third person plural, changes *evant* into *oivent.*

2nd, The Imperfect Indicative, by the change of *ant* into *ais, ais, ait, ions, iez, aient.*

3rd. The Present Subjunctive, by the change of *ant* into *e, es, e, ions, iez, ent*, except the third conj., which changes *evant* into *oive, oives, oive, evions, eviez, oivent.*

e. The Past Participle forms all the Compound Tenses by means of *avoir* and *être.*

f. The Present Indicative forms the Imperative by suppressing the pronouns *tu, nous, vous*, in all verbs, and by the omission of the characteristic *s* of the second person sing. in all verbs of the first conjugation, and those ending in *ueillir, frir*, and *ouvrir.*

g. The Perfect Definite forms the Imperfect Subjunctive, by adding to the characteristic vowel the terminations *sse, sses, ^t, ssions, ssiez, ssent.* The characteristic vowel of the first conj. is *a*; of the second, *i*; of the third, *u*; of the fourth, *i.*

The vowel immediately preceding the *t* of the third person sing. takes, as marked above, a circumflex accent, on account of the suppressed *s.* (See No. 2, *c.*) The first and second persons plural of the Perf. Def. have a circumflex over the characteristic vowel, but this is dropped in the Imperf. Subj.

Practical Application.

1. VOCABULARY XIII.

Le Temps et ses Divisions, *Time and its Divisions.*

a. Il y a quatre saisons (*there are four seasons*):—

le printemps	*spring.*
l'été, *m.*	*summer.*
l'automne, *m.* or *f.*	*autumn.*
l'hiver, *m.*	*winter.*

b. Les termes en Angleterre sont (*the English term-days are*):—

l'Annonciation, ou fête de Notre-Dame de mars	*Lady Day.*
la Saint-Jean *	*Midsummer.*
la Saint-Michel	*Michaelmas Day.*
la Noël †	*Christmas.*

[These correspond to what in France are called the terms of *Touraine.*]

c. Les termes en Ecosse sont (*the Scottish terms are*):

la chandeleur	*Candlemas.*
la Pentecôte	*Whitsuntide.*
la Saint-Pierre-ès-liens	*Lammas*
la Saint-Martin	*Martinmas.*

[Some of these terms obtain here and there in France, the more general practice being to consider 1st January, 1st April, 1st July, and 1st October as term days.]

d. Il y a douze mois dans l'année (*there are twelve months in the year*):

janvier,	*January.*	juillet,	*July.*
février,	*February.*	août (*ou*)	*August.*
mars,	*March*	septembre,	*September.*
avril,	*April.*	octobre,	*October.*
mai,	*May.*	novembre,	*November.*
juin,	*June.*	décembre,	*December.*

e. Les jours de la semaine (*the days of the week*):

dimanche,	*Sunday.*	mercredi,	*Wednesday.*
lundi,	*Monday.*	jeudi,	*Thursday.*
mardi,	*Tuesday.*	vendredi,	*Friday.*
		samedi,	*Saturday.*

* It would be more logical to state the rule thus: The future is formed by adding *ai, as, a, ons, ez, ont*, to the infinitive of the 1st and 2nd conjugations, and by changing *oir* and *e* of the 3rd and 4th into *ai, as*, etc. But the terseness of our rule will perhaps commend itself to the memory of the learner.

* The word *Saint* takes a capital and is joined by a hyphen to the noun it qualifies, when it forms with it a name which is not applicable to a saint, or only refers to a saint indirectly: *le village de Saint-Cloud*, or absolutely *Saint-Cloud; la rue Saint-Honoré; la porte Saint-Antoine; la prison de Sainte-Pélagie*, or absolutely *Sainte-Pélagie; l'église Saint-Germain*, or absolutely *Saint-Germain*, etc. In speaking of the saints themselves write *saint Jean, saint Cloud, sainte Pélagie*, etc., with a small initial and no hyphen.

† *Noël* is masculine: *un beau Noël.* It is feminine in this acceptation because the expression is elliptical: *la Noël = la fête de Noël.*

f. un siècle,	*century.*	une quinzaine,	*fortnight.*
un an, une année	*year.*	une semaine,	*week.*
année bissextile	*leap year.*	un jour, une journée	*day.*
un semestre,	*half a yr.*	une heure,	*hour.*
un trimestre,	*quarter.*	une minute,	*minute.*
un mois,	*month.*	une seconde,	*second.*

XXVII.

Astronomical Calculations.

Having thus described the general character of the members of the solar system, it will be well to give some more detailed account of the nature of the orbits in which they move, and of the manner in which astronomers are able to calculate the places of the planets, etc., in their orbits at any given time.

The size, form, and position of the orbit of a planet is fixed by five elements, as they are called, and when the arithmetical values of these are known it is possible to lay down a plan of the exact elliptical orbit in which the planet is moving. These elements are:—

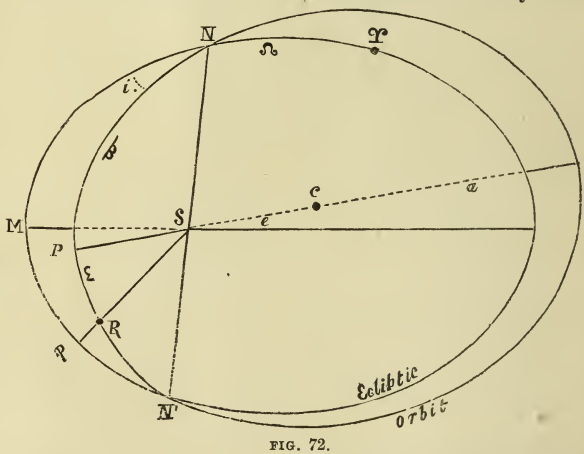


FIG. 72.

I. The *Semi-axis Major*, or *Mean Distance*, commonly denoted by the letter *a*. It is equal to half the longer diameter of the ellipse forming the orbit of the planet—that is, to CA or CP in fig. 72. The mean distance of the earth is commonly taken as unity: thus the mean distance of Jupiter is said to be 5·2028, or is 5·2028 times that of the earth.

II. The *Eccentricity*, commonly denoted by the letter *e*. This is equal to the distance of the foci from the centre, the mean distance of the planet being taken for unity. It is SC on fig. 72.

These two elements determine the size and form of the orbit.

III. The *Longitude of Perihelion*, commonly denoted by ω, or occasionally by π. This represents the longitude of the point on the orbit where the planet approaches closest to the sun; it is equal, therefore, to the longitude of the end of the major axis of the ellipse which is nearest the sun. This longitude, like all other longitudes, is measured from the point on the ecliptic where it cuts the celestial equator on passing from the southern to the northern hemisphere—a point called the *vernal* equinox. On the figure ♈ may be supposed to denote the vernal equinox, when $\Upsilon N + NP = \omega =$ the longitude of perihelion.

This element determines the position of the orbit with regard to the sun.

IV. The *Inclination*, commonly denoted by *i*. This represents the angle made by the plane of the orbit with the plane of the ecliptic. It is equal to the angle made by NP with NM on the figure.

V. The *Longitude of the Ascending Node*, commonly denoted by ☊. This represents the longitude of the point where the orbit cuts the ecliptic in passing from the south to the north, or to ΥN on the figure.

These two elements determine the position of the plane of the orbit in space.

These five elements give astronomers all the information they require about the form, size, and position of the orbit of a planet; but to these there is usually added a sixth, which enables them to ascertain at what part of its orbit the planet is at any moment. This additional element is—

VI. The *Longitude of the Epoch*, commonly denoted by ϵ. This is the mean longitude of the planet at some given instant. If R be the position of the planet at this epoch, then $\epsilon = \Upsilon N + NR$ on the figure. Usually it is the beginning of the year 1800, 1801, or 1850. In the case of comets this element is commonly replaced by the instant of passing its perihelion, and it is then commonly denoted by the letters *pp*.

The preceding six quantities constitute what astronomers call the elements of the orbit of a planet; but there are some other similar quantities to which astronomers often refer, which should be therefore described. They are the following:—

The *mean motion*, *n*.—It may be conveniently described as being equal to 2π, or 360° divided by the number of years which a planet takes to make a complete revolution. Suppose it be T years of $365\frac{1}{4}$ days each, then

$$n = \frac{2\pi}{T} = \frac{360^\circ}{T} = \frac{1296000}{T}$$

Thus, in the case of Jupiter, the planet takes 11·862 years to make a complete revolution; hence

$$n = \frac{1296000}{11\cdot862}\ '' = 109256\ '' = 30^\circ 34' 9''.$$

The mean motions are usually given in seconds of arc, but are more convenient in degrees. Under these conditions the unit of time will be one year of 365¼ days. The mean motion and the mean distance of a planet are connected together by the law

$$n^2 = \frac{1}{a^3} \text{ or } n^2a^3 = 1;$$

only where this law is used, n must be expressed in circular measure by multiplying the number of degrees by the circular measure of one degree (= 0·0174533).

The *mean longitude*, l.—Suppose the planet to move in a circle round the sun at a uniform rate, so that it takes exactly the same time to make one complete revolution as the planet actually requires in its elliptic orbit. It must obviously move, therefore, in this circle at the same rate as its mean motion, and in any time t it will have moved through an angle equal to nt. Let t be reckoned from any instant assumed as an *epoch*, and by definition the mean longitude of the planet at that instant is denoted by ϵ. Then at the time t the mean longitude, l, of the planet will be equal to ϵ *plus* the angle nt it has moved through in the time t, or

$$l = nt + \epsilon.$$

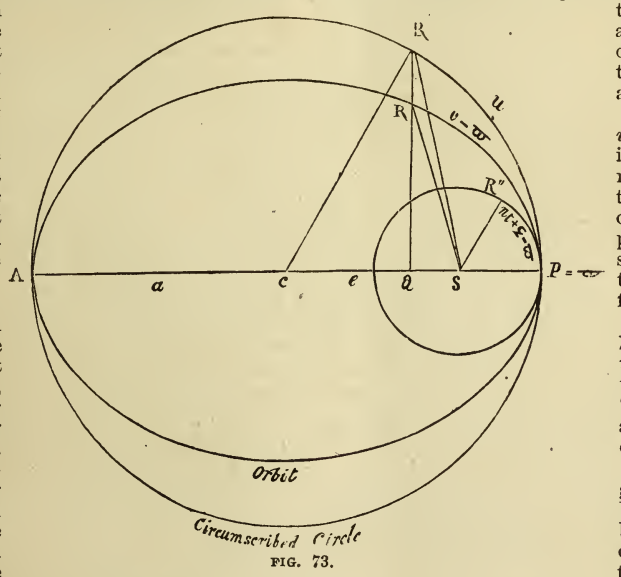


FIG. 73.

In fig. 73 P R A represents the elliptical orbit of the planet, the sun being at S, and P being the perihelion. P R′ A is a circumscribing circle drawn round the ellipse from the same centre C, and P R″ is a smaller circle drawn round the sun as a centre. In the figure R is supposed to be the actual place of the planet in its elliptical orbit, and R″ the place of the fictitious planet which is supposed to move uniformly in a circle round the sun in the same time as the actual planet R. The two planets R and R″ are always supposed to reach perihelion together, and of course they then coincide in position. Thus R is termed the *true longitude*, v, of the planet, and R″ is termed the *mean longitude*, l. At P these two longitudes are the same, so that ω, the longitude of the perihelion, may be regarded either as its *true longitude* or as its *mean longitude*, as may be most convenient.

The *mean anomaly*.—This is equal to the mean longitude of the planet measured from the perihelion instead of from the vernal equinox. It is equal, therefore, to the mean longitude, l, less the longitude of the perihelion, ω, or

$$\text{Mean anomaly} = l - \omega - nt + \epsilon - \omega.$$

In the figure it is equal to the angle P S R″.

The *true anomaly*.—This is equal to the true longitude, v, less the longitude of the perihelion, ω, or

$$\text{True anomaly} = v - \omega.$$

In the figure the true anomaly is equal to the angle P S R.

The *anomalies*, therefore, only differ from the longitudes in being measured from the perihelion of the planet instead of from the vernal equinox.

The *eccentric anomaly* is equal to the angle P C R′, and is commonly denoted by u. Suppose a line drawn perpendicular to the major axis through the place of the planet R to the circumscribing circle, it will cut it at R′; then the angle at the centre of the ellipse between R′ and P is equal to the eccentric anomaly. It is obvious that when the planet is in perihelion the eccentric anomaly coincides with the true and mean anomalies.

The *radius vector*, r.—This is the distance measured on the plane of the orbit of the planet from the sun, and is equal to R S in the figure.

The *latitude*, λ, is equal to the angular distance P S R (fig. 72) of the planet above the ecliptic.

It remains to give the algebraical relation between these different quantities, so that one can be calculated from the other. These relations are —

$$nt + \epsilon - \omega = u - e\sin u$$

$$\tan\frac{v-\omega}{2} = \sqrt{\frac{1+e}{1-e}}\tan\frac{u}{2}$$

$$r = a(1 - e\cos u) = \frac{a(1-e^2)}{1+e\cos(v-\omega)}$$

$$\sin\lambda = \sin i\sin(v - \Omega)$$

In general, however, astronomers want to calculate the longitude, radius vector and latitude of a planet at some given time; and for that reason they have transformed the above formulæ into others which give them the values of these quantities directly in terms of the mean longitude or the time, without its being necessary to proceed from one calcu-

lation to another. It is only possible, however, to give this second form to the formulæ by means of approximations in the form of long series of terms ; but by taking enough of these terms into account, the result can be obtained as accurately as may be required. In the following expressions there have been omitted terms involving the third and higher powers of e:—

$$v = nt + \epsilon + 2e\sin(nt + \epsilon - \omega) + \tfrac{5}{4}e^2 \sin 2(nt + \epsilon - \omega) + \ldots.$$

$$r = a\left\{\begin{array}{l} 1 + \tfrac{1}{2}e^2 - e\cos(nt + \epsilon - \omega) - \tfrac{1}{2}e^2 \\ \cos 2(nt + \epsilon - \omega) + \ldots\ldots \end{array}\right\}$$

$$\lambda = \sin i \sin(v - \Omega)$$

$$= \sin i \left\{\begin{array}{l} \sin(nt + \epsilon - \Omega) + e.\sin(2nt + 2\epsilon \\ - \omega - \Omega) + e\sin(\Omega - \omega) + \ldots. \end{array}\right\}$$

In this case the true longitude, v, is supposed to be measured on the plane of the orbit of the planet; when it is intended to find the place of the planet in the heavens, it is usual to suppose the longitudes to be measured on the ecliptic;

XXVII.

THE VERB (*continued*).

§ 179. *Tense.*
§ 180. Table of tenses.
§ 181. Explanation of tenses.
§ 182. Present indefinite.
§ 183. Past indefinite.
§ 184. Future.

§ 179. **Tense** (*tempus*, *temps*, time).—As many as eighteen different degrees of time in one mood are given by some grammarians, and they undoubtedly can be expressed,—even more. In English this cannot be done by inflexion. We have but two tenses shown by this means, therefore all the other tenses are expressed by help of secondary verbs combined with either the infinitive or a participle of the

TABLE OF THE ELEMENTS OF THE EIGHT PRINCIPAL PLANETS, ACCORDING TO LEVERRIER'S TABLES.
Epoch 1850·00. (Mid-day, Jan. 1st, 1850, Paris Mean Time.)

Name.	Mean distance.	Motion of Mean Longitude.	Eccentricity.	Longitude of Perihelion.	Inclination.	Longitude of Node.	Longitude at Epoch.
	a	l	e	ω	i	Ω	ϵ
Mercury . .	0·3870987	4ʳ 54°·76071	0·205605	75° 7′ 14″	7° 0′ 8″	46° 33′ 9″	327° 15′ 20″
Venus . . .	0·7233322	1ʳ 225°·19212	0·006843	129° 26′ 35″	3° 23′ 35″	75° 19′ 44″	245° 33′ 17″
Earth . . .	1·0000000	1ʳ 0°·00769	0·016771	100° 21′ 21″	0° 0′ 0″	0° 0′ 0″	100° 46′ 43″
Mars . . .	1·523691	191°·41696	0·093261	333° 17′ 54″	1° 51′ 2″	48° 23′ 53″	83° 40′ 31″
Jupiter . . .	5·20280	30°·36301	0·048252	11° 54′ 58″	1° 18′ 41″	98° 56′ 17″	159° 56′ 13″
Saturn . . .	9·53885	12°·23508	0·055943	90° 6′ 56″	2° 29′ 40″	112° 20′ 53″	14° 50′ 28″
Uranus . . .	19·14169	4°·29864	0·046341	170° 50′ 7″	0° 46′ 20″	73° 13′ 54″	29° 17′ 51″
Neptune . .		2°·19886	0·008964	45° 59′ 43″	1° 47′ 2″	130° 6′ 25″	334° 33′ 29″

in this case the following additional term must be added to the expression for v:—

$$-\tfrac{1}{4}\sin^2 i \sin 2(nt + \epsilon - \Omega)$$

It will be seen, therefore, that these formulæ enable us to calculate the longitude, radius vector and latitude of a planet, and therefore its place in the heavens, when we know the value of the six quantities or elements a (and therefore n), e, ω, i, Ω, and ϵ.

The values of these quantities are given in the table, where instead of n there has been given l, the motion in the mean longitude, a quantity which is larger by 50·23,″ the *precession*, as it is termed, or amount by which the vernal equinox moves backwards each year. Each of these elements or quantities is subject to slow variations, so that their values become slightly changed during the course of many years, but these alterations proceed so slowly that it takes centuries before any sensible change occurs.

The scale of the solar system.—To gain an idea of the scale of the solar system take a globe a little over two feet in diameter to represent the sun : Mercury will then be proportionally represented by a grain of mustard seed, the Earth by a pea, Mars by a rather large pin's head, and Jupiter by a moderately sized orange.

principal verb. As the mere names of so many tenses are extremely puzzling unless the principle on which they are formed is understood, the student should try to comprehend this in the simple form, and then he can make any number of tenses for himself.

In Old English there were but the two tenses, *past* and *present*, shown by inflexion; the others . . . . which may be called compound forms, have grown up by degrees, as the need for expressing precise shades of thought arose; the beginnings of some of them can be traced. (*Morris.*)

§ 180. There are three *classes* of time—*Present*, *Past*, and *Future*: as, I *write*, I *wrote*, I *shall write*. Of each of these three classes there are four well-marked species, making twelve tenses to be borne in mind ; two of these—the present indefinite (I *write*) and past indefinite (I *wrote*)—are formed by inflexion ; as all the other tenses are formed with the help of auxiliary verbs, it follows that the number of tenses we can make is only limited by the number of these verbs which are capable of conveying a sense of time. The following is a table of the twelve chief tenses, which it will be noticed are formed with the aid of the three verbs *to be*, *to have*, and *shall*.

Present	indefinite	write
„	continuous . . .	*am* writing
„	perfect	*have* written
„	perfect continuous	*have been* writing
Past	indefinite	wrote
„	continuous . . .	*was* writing
„	perfect	*had* written
„	perfect continuous	*had been* writing
Future	indefinite	*shall write*
„	continuous . . .	*shall be* writing
„	perfect	*shall have* written
„	perfect continuous	*shall have been* writing

§ 181. The names given to these tenses closely express their meaning. Unconsciously, in our minds we allot a floating space of time to the division we call Present, but there are distinctions even in that: if we *write*, it is at *any point* of time within the present, so it is *indefinite;* in we *are writing*, we continue the action in the time still going on; when we *have written*, the action is perfect or complete within the present space of time about us. An accompanying adverb often limits the time: "I *have written* to your sister *to-day*," "I *have* written six quires *since* Friday week;" but we could not say "I *have written* to your sister *yesterday*," nor, in answer to the query "*Have* you *ever* seen John?" say "I *have* seen him *last year*." When we say, "We *have been writing* to-day," it is a description of the action while it was going on that is finished within the present; this is the *continuation* of the *perfect*. This, too, is limited by adverbs of a *present* significance: we cannot say, "I have been writing *last year*." It is the same with the other divisions of time: looking back, we have an unknown space of *past*, looking forward, an unknown space of *future;* in each we have an indefinite point and a continuous action, a perfect and a perfect continuous.

In logical order of time we ought to read *past, present,* and *future,* also to place the perfect continuous *before* the perfect, but to save confusion the usual method of grammars is here followed. The perfect continuous is not formed in passive verbs.

Some add to the above tenses an *intentional*, "I am going to write," and a *continuous intentional*, "I have been going to write," for each class of time. We may make others out of "I do write," "I did write," "I ought to be writing," etc.

These tenses are found in the *indicative* and *subjunctive* moods of active verbs; the imperative takes but one time, the present. In passive verbs many of these tenses are wanting—viz., all the *continuous* tenses, except the present-continuous and past-continuous of the indicative, with occasionally the future-continuous of the indicative and the past-continuous of the subjunctive. (See after, § 199.)

§ 182. There are yet several other senses served by two of these tenses. *Present indefinite.* 1. It often bears a future sense, as "I go to London next week," "Duncan comes here to-night" (Shakespeare). 2. It is used in describing an habitual or a constant action, and the existence of a general truth: "lions roar, dogs bark," or "the lion roars, the dog barks" (we can employ either singular or plural); "I write much," "he often bathes," "honesty is the best policy." 3. It is often used in quoting the words of an author, however long ago he lived: "Solomon saith, all is vanity," "Shakespeare represents Falstaff as fat." 4. It is called the *Historic present* when "in lively narrations the speaker or writer imagines himself to be present at the events he is describing, and so uses the present tense in speaking of past events" (*Mason*). Example:

"[Satan] now prepared
To speak; whereat their doubled ranks they *bend*
From wing to wing, and half *inclose* him round
With all his peers: attention held them mute."
MILTON, *Par. Lost*, Bk. I., l. 615.

§ 183. *Past indefinite.* This is, like the present indefinite, used to express an habitual action, as well as one at a point of time: "he wrote for the newspapers," "she dabbled in science." It is also sometimes used in serious writing, or by old writers, where we usually employ the past-continuous: "But as they sailed [*i.e.* were sailing] he fell asleep" (Luke viii. 23). This old usage shows the growth of a new tense.

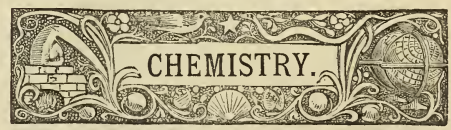
§ 184. *Future tense.* There was in Old English no form for future time; the present did this duty (*see* above, § 182, 1). But by degrees, from the thirteenth century, the combination of *shall* or *will* with the infinitive came into use to show future time. *Shall* involves the idea of command, and is therefore used in the first person (*I* and *we*) only, to express the future: "I shall be drowned." *Will* includes volition when used *by* the first person, but used *of others*, the second and third persons, it expresses the future. Thus, to express merely the future sense, we have:

I shall (or will) write	we will write
thou wilt write	you will write
he will write	they will write.

Shall is used of the second and third persons in the sense of command: "thou *shalt* not steal," "he *shall* be hung;" also of promise or permission: "you shall have it," "he shall go." In asking questions *shall* is used by the first, *will* by the second and third persons:

shall I go?	shall we run?
wilt thou go?	will you have this?
will he do it?	will they die?

In each of these cases a sense of will or of compulsion is implied if the verb is exchanged: *will* I go? etc.



XXVI.

POTASSIUM.

THE preparation of this metal from potash and carbon, which are heated together in a retort, is attended with no small amount of difficulty, and even danger, unless great care is exercised. It is a bright silvery-looking metal, which, like sodium, has so strong an affinity for oxygen that it cannot be kept in the air or even in water. In the air it is rapidly con-

Attributes of potassium.

verted, by slow combustion, into a white powder, its oxide. If thrown upon water this metal exhibits the singular phenomenon of combustion in that liquid. Floating on the surface, its specific gravity being less than that of water, it decomposes that fluid, uniting with the oxygen and one atom of hydrogen to form potash or potassium hydroxide, and liberating the other atom of hydrogen. The hydrogen, thus set free, is kindled into flame by the energy of the chemical action that takes place, and gives out a beautiful purple light in burning.

Decomposition of water by potassium.

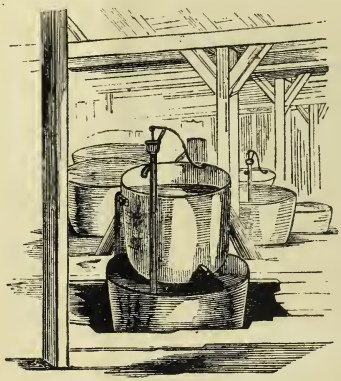
At ordinary temperatures potassium is so soft that it can be easily cut with a penknife. At freezing point it becomes brittle. At 62½° it melts, and if heated up to a point below red-heat it volatilizes with the production of a green-coloured vapour. Potassium also combines with great energy with chlorine, sulphur, and many of the non-metals. From what has been said of this metal, it will readily be assumed that we never meet with it pure or uncombined in a state of nature. Its compounds are known to exist in the felspar of the granitic rocks, but hitherto no cheap and ready method has been discovered of reducing the metal from this substance. What the art of man has failed to accomplish, however, the organic process of the growth of plants has, to a certain extent, effected by taking up and assimilating a certain portion of the potash contained in the soil. This may be obtained by burning the plant and washing the ashes in water. The soluble potash, set free by evaporation, crystallizes in the form of the substance known as pearlash, and is the principal source of the potassium compounds. Two other of the potassium salts, the nitrate and the chloride, exist abundantly in a state of nature in various localities as a deposit on the surface of the earth, or imbedded in the interior. The former of these is the well-known and important substance nitre, the latter is an analogue of table salt. The sea-water, holding as it does a large quantity of the potassium compounds in solution, ought to furnish an inexhaustible supply, if a cheap and efficient means of obtaining them could be devised.

Potassium compounds in their native state.

Source of potassium compounds.

Potassium nitrate and chloride.

Sea water a source of potassium compounds.



THE APPARATUS OF SOAP MAKING.

Potassium forms three distinct compounds with oxygen—a monoxide, a dioxide, and a tetroxide. The first of these is produced by the simple oxidation of the metal in dry air; for the production of the two latter compounds it will be found that a high temperature is required.

Potassium Carbonate.

This useful salt, commonly known by its commercial name of potashes or pearlashes, is imported in large quantities from Russia and America. It is prepared in the manner we have already specified from plants. This salt, which is strongly alkaline, has a powerful affinity for water, combining with that which is present in the atmosphere and being therefore a deliquescent salt. Potassium hydroxide, or caustic potash, formed when the metal potassium is thrown upon water, is prepared from the carbonate. This substance is a white solid, soluble in water and acting as a powerful cautery—that is, destroying the skin, whence its name. It is used in many of the arts and manufactures, especially in soap-making. The salt known as the bicarbonate is likewise prepared from the carbonate,—it may be regarded as carbonic acid in which one atom of hydrogen is replaced by one of the monad metal potassium; thus H_2CO_3 becomes $HKCO_3$.

Caustic potash.

Potassium Nitrate (nitre or saltpetre).

This salt, which derives especial importance from the fact of its being one of the principal constituents of gunpowder, is met with as an efflorescent salt in many tropical countries, and is also prepared artificially from decaying animal nitrogenous matter. It is much more soluble in warm than in cold water. On heating with carbon, this salt parts readily with its oxygen, of which it contains a large proportion. This tendency to sudden decomposition explains its use in the manufacture of gunpowder. The proportion in which it enters into that important explosive agent varies but very slightly in the different kinds of gunpowder; being always in the ratio of about seventy-five per cent., or three-quarters of the whole: one hundred parts of English gunpowder contain seventy-five of nitre to fifteen of charcoal and ten of sulphur; in some foreign powders the proportion of sulphur is slightly in excess of this. Of the other salts of potassium it is unnecessary to speak. We have already drawn attention to potassium chloride, KCl, as an analogue of common table salt, while the reader will probably remember that potassium chlorate, $KClO_3$, is the salt from whose decomposition oxygen can most conveniently be obtained. It will be seen that the letter K is the symbol of potassium, which stands for the name by which it is chemically distinguished—Kalium, a word derived from the Arabic.

Preparation of potassium nitrate or saltpetre.

Its use in the manufacture of gunpowder.

Sodium

Is a metal presenting many striking points of analogy with potassium. Its specific gravity is somewhat greater than that of the latter, but is still less than that of water. Its appearance is not unlike that of potassium, it is equally soft at ordinary temperatures, fuses at 95½°, and under similar conditions assumes the form of a gas, which in the case of this metal is however invisible. It decomposes water in the same manner as potassium, but the liberated hydrogen does not take fire unless the water be heated. The sodium compounds are universally diffused throughout nature. They exist in the earth we inhabit, in the waters of the ocean, in the air we breathe, and in all organic structures.

Sodium similar in its nature to potassium.

Sodium universally diffused.

Most of the sodium compounds are in the present day prepared from the well-known table salt—a substance which occurs in thick beds below the surface of the earth, in many parts of the world. Some of the most remarkable and extensive salt mines in the world exist near Wielizka, in Austrian Poland. Salt may also be obtained by the evaporation of sea-water, as well as that of various brine springs. When allowed to crystallize slowly, sodium chloride crystallizes in regular cubes.

THE MANUFACTURE OF SOAP.

Sodium forms two compounds with oxygen, while sodium hydroxide is an analogue of potassium hydroxide or caustic potash, which it resembles in many of its properties.

Sodium Carbonate.

This salt is of sufficient importance to demand a few words of special notice, being manufactured on a very large scale in this country, on account of its use in glass-making, bleaching, soap-making, and many other industrial processes. It is prepared from sea-water, the sodium chloride of which is first decomposed by treating with sulphuric acid; the chlorine being given off, combined with hydrogen, as hydrochloric acid, while the metal sodium forms a sulphate with the sulphuric acid. The next step consists in the conversion of the sulphate into the carbonate by heating it in a furnace with charcoal, or coal and carbonate of lime, chalk or limestone. The first result is the conversion of the sulphate into a sulphide, Na_2S; the sodium of which, displacing the calcium of the limestone, gives rise to sodium carbonate, while the calcium unites with the sulphur to form calcium sulphide. The sodium carbonate, being soluble in water, is finally separated from the insoluble calcium sulphide and other impurities, by what is termed lixiviation, a process by which we are enabled to separate a soluble substance from any insoluble ones with which it may be associated. If any saturated solution of calcium carbonate, or soda ash, be allowed to stand it assumes the crystalline state in what is known as soda crystals, so much used in the laundry for softening water. Sodium carbonate occurs naturally in small quantities, as an efflorescence of the soil in certain localities. The salt, known as the bicarbonate, is prepared by exposing the crystals of the carbonate to an atmosphere of carbonic acid gas. An immense quantity of common salt is annually converted into sodium carbonate in the alkali works of Great Britain. Sodium nitrate, a salt corresponding to potassium nitrate or saltpetre, is found in large quantities in Peru and northern Chili, and is known in commerce as Chili saltpetre. It is exported in large quantities, being used as manure, as well as in the preparation of nitric acid. Sodium sulphate, commonly known as Glauber's salts, occurs naturally in the water of many mineral springs. Its use in medicine is well known; while in the anhydrous form, or as what is termed salt cake, it is employed in the manufacture of glass. The sodium salts are very numerous, and are distinguished, with a single exception, by the fact of their solubility in water.

Preparation of sodium carbonate.

Separation by lixiviation.

Soda crystals.

The bicarbonate.

Glauber's salts.

Lithium.

This metal may be regarded as forming the link between the metals of the alkalis and those of the alkaline earths. It is of a white colour, easily fusible, and is the lightest metal known. The lithium salts are widely distributed, although occurring generally in small quantities. They are held in solution both by natural waters and organic

Nature of lithium.

Lithium salts.

fluids. The metal itself is never met with pure or native, and is generally prepared by the decomposition of its chloride by electricity. Two new metals have recently been discovered and added to the list of the alkaline series; they are termed cæsium and rubidium. They have been found, in small quantities, in the waters of many mineral springs, as well as in various organic structures.

Cæsium and rubidium.

XXX.

Defective and Impersonal Verbs.

Defective verbs are those which are deficient in some of their tenses, or whose tenses are deficient in some of their persons, as the following: *cœpi*, I began; *memini*, I remembered and do remember; *odi*, I have hated and do hate; *aio*, I say "yes" or ay, and so affirm (as opposed to its compound *nego*, which is made up of *ne*, not, and *ajo* or *aio*, I say yes); *inquam*, quoth I (for *injiciam*, I will throw in (a word), and so always used with *quoted* words); and *fari*, to speak (a deponent).

Cœpi, Memini, and **Odi,** have no present-stem tenses:—

INDICATIVE.

Perfect	cœpī,	mĕmĭnī,	odī.
Fut.-Perf.	cœpĕro,	mĕmĭnĕro,	oderо.
Pluperf.	cœpĕram,	mĕmĭnĕram,	oderam.

SUBJUNCTIVE OR CONJUNCTIVE.

Perfect	cœpĕrim,	mĕmĭnĕrim,	oderim.
Pluperf.	cœpissem,	mĕmĭnissem,	odissem.

IMPERATIVE.

Future	(wanting),	mĕmento, mĕmentōte,	(wanting.)

INFINITIVE.

Perfect	cœpissĕ,	mĕmĭnissĕ,	odissĕ.

PARTICIPLE.

Future	cœptūrŭs,	(wanting,)	osūrŭs.

Aio, *I affirm.*

INDICATIVE.

Present.	aiŏ,	aïs,	aït,	—	— aiunt.
Imperf.	aiēbam (complete).				

CONJUNCTIVE.

Present	—	aiās,	aiăt,	—	— aiant.

Inquam, *I say.*

INDICATIVE.

Present.

inquam, inquïs, inquït, inquĭmŭs, — inquiunt.

Imperfect.

— — inquiēbăt, — — inquiēbant.

Simple Future.

— inquiēs, inquiĕt, — — —

Perfect.

— inquistī, inquït, — — —

IMPERATIVE.

Present.

— inquĕ — inquïte, — —

Fari, *to speak.*

Indic.	*Present.*	fatur.
	Future.	fābor, fabitur.
	Perfect.	fatus sum.
	Pluperfect.	fatus eram.
Subj.	*Perfect.*	fatus sim.
	Pluperfect.	fatus essem.
Imper.	*Present.*	fare.
Infin.	*Present.*	fari.
Part.	*Present.*	fantis, gen. (but no nominative in use).
	Perfect.	fatus, -a, -um.
	Gerundive.	fandus, -a, -um.
	Supine.	fatu.
	Gerunds.	fandi, -do, -dum.

Impersonal verbs, or rather *unipersonal* verbs (as they have *one* person, the third singular), are conjugated only in the third person singular, and sometimes in the imperative mood. The pure impersonals have no passive voice, and are generally of the second conjugation; but many intransitive verbs are used impersonally in the passive voice, as *pugnatum est a nobis*, it has been fought by us, that we have fought. Some impersonals govern the accusative case, and some the dative case.

Impersonals pure and quasi-impersonals are used in the following way:—

With Acc.	ŏportĕt,	dĕcĕt,	dēdĕcĕt,
	it behoves.	becomes.	misbecomes.
	pĭgĕt,	pŭdĕt,	pœnĭtĕt,
	it irks.	shames.	repents.
	tædĕt,	mĭsĕrĕt.	—
	it disgusts.	moves pity.	
With Dat.	lĭbĕt,	lĭcĕt.	lĭquĕt,
	it pleases.	is lawful.	is clear.
With ad *and Acc.*	attĭnĕt, it relates.	pertĭnĕt, belongs.	—

The persons are expressed by the cases following the verb, as:—

ŏportĕt { mē, it behoves me / tē, „ thee / eum, „ him / nōs, „ us / vōs, „ you / cōs, „ them } or { I ought. / thou oughtest. / he / we / you / they } ought.

lĭcĕt { mĭhĭ, it is lawful for me / tĭbi, „ thee / eī, „ him / nōbīs, „ us / vōbīs, „ you / iīs, „ them } or { I may. / thou mayest / he / we / you / they } may.

When intransitive verbs are used impersonally in the passive, as *lūdĭtŭr*, it is played, the persons are expressed by an ablative with the preposition *ā, ăb*, following the verb, as:—

lūdĭtŭr { ā mē, it is played by me, or I play. / ā tē, „ thee, or thou playest. / ăb eō, „ him, or he plays. / ā nōbīs, „ us, or we play. / ā vōbīs, „ you, or you play. / ăb iīs „ them, or they play.

The neuter of the gerundive participle is used impersonally in the same way with a dative, as :—

lūdendum est { mihi, it must be played by me, or I / tibi, „ thee, or thou / eī „ him, or he / nōbīs, „ us, or we / vōbīs, „ you, or you / iīs, „ them, or they } must play

The impersonal form is often found of the greatest service for the employment of verbs in the passive which govern a dative in the active, for they have no passive except as impersonals. Thus, instead of saying I am spared, I am believed, I am persuaded, the Romans said, it is spared to me, it is believed to me, it is persuaded to me. As an example take the following :—

mihi ereditur,	ereditum est	I am, I have been believed.
tibi „	„	thou art and wast believed.
illi „	„	he is or was believed.
nobis „	„	we are, we have been believed.
vobis „	„	ye are or were believed.
illis „	„	they are or were believed.

Observe (1) that the impersonals are used in all tenses and moods : as *mihi licuit*, it has been lawful for me ; *mihi licebit*, it will be lawful for me ; *liceret mihi*, it might be lawful for me. (2) The present infinitive, not a past tense, follows *licuit* and *oportuit*, in spite of the English "have," as I might have gone is *mihi* IRE *licuit*, not *ivisse licuit*.

Many impersionals, besides the accusative of the subject, govern a genitive of the object, as for example :—

I repent of my folly,	me meæ stultitiæ pœnitet.
I am vexed at my folly,	me meæ stultitiæ piget.
I am weary of my folly,	me meæ stultitiæ tædet.
I am ashamed of my folly,	me meæ stultitiæ pudet.
I pity the poor,	me pauperum miseret.

The imperative is not found amongst impersonal verbs ; but to express it you may use the present subjunctive, as, repent of thy sin may be rendered *te tuæ peccati pœniteat*, let it repent thee of thy sin.

The following impersonals denote atmospheric changes :—

grandĭnăt, āvĭt, ārĕ, it hails.
ningĭt, ninxĭt, ningĕrĕ, it snows.
plŭĭt, plŭĭt or plūvĭt, pluĕrĕ, it rains.
tŏnăt, tŏnuĭt, tŏnārĕ, it thunders.
lūcescĭt (illuxit), lūcescĕrĕ, it becomes light, *or* it dawns.
vespĕrascĭt, vespĕrāvĭt, vespĕrascĕrĕ, evening comes on.

Questions for Self-Examination and Exercises.

Define a defective and an impersonal verb, and give examples of each. What is a better name for an impersonal verb, and why? What defective verbs are wanting in the present stem tenses? What is the derivation of *nego?* Give the remaining tenses of *inquam*, and its derivation? Give the participle of *fari*. How may intransitive verbs be used impersonally? Where only can a verb govern a dative in the passive, if it governs a dative in the active voice? What impersonals take the accusative case? what the dative? and what the genitive case? When is the preposition *a* or *ab* used with an impersonal verb? How can you use the gerundive participle impersonally? Give examples. What substitute can you use for the imperative mood in impersonal verbs? Write out the impersonals that denote atmospheric changes.

Translate into English :—

Hoc facto, alias res agere cœpi. "Hanc perde urbem," inquiebat, "ferro et flammâ." Se venturum esse cito ait. Talia unquam dixisse negaverat. Memento mori. Te consulere Deos maxime oportet. Omnes vera dicere decebat. Nonne vos omnes sanguinem profundere pro patriâ decuit? Ire ad urbem tibi licuit. Vosne vestræ stultitiæ unquam pœnitebit? Ab hostibus nostris prope montes trans flumen satis bene pugnatum est. Vobis a me semper ereditur. In aperto et claro cœlo fulgurat et tonat. Me tuorum laborum gravissime miseret. Deus piorum, qui tot mala patiuntur, miserebit. Nos amicos summâ stultitiæ puderit. Mihi me tantum argenti et auri, ab hostibus receepti, habere licuit?

Translate into Latin :—

I feel the greatest pity for the misfortunes of my friends. He is believed by all. No one is ashamed of his folly. "Shall these trees," said he, "produce any fruit?" He affirms that I ought to have gone into the city with a multitude of soldiers. It rains, and will soon thunder. Do not be ashamed of poverty, which is often a great and useful gift of the good gods, who love thee. You must fight, if you will have the highest praise of the very bravest soldiers and of the best citizens. He must struggle for victory bravely, if he wishes to obtain it, and to conquer his many enemies.

XXV

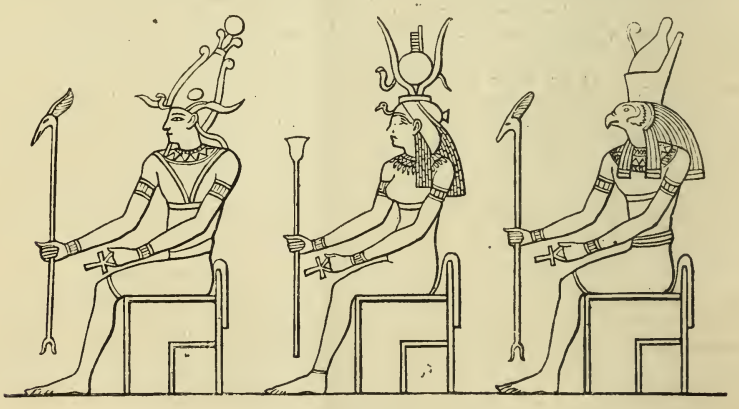
EGYPT (*continued*).

THE earliest known native name of Egypt was Kem (sometimes rendered Chem, or Chemi), signifying, both in the old language and modern Coptic, "black," probably given as descriptive of the blackness of the alluvial soil. The eastern branch of the Nile is spoken of

in the Bible as Shihor, "the black river," no doubt from the richness of the deposits brought down. The Egyptians themselves named the river Hapee, or Hapee-mu, "the abyss," or "the abyss of waters." The Greeks, at a much later period, named the land Aiguptos (the derivation of which is unknown), from which the modern name is taken.

Previous to the first historic dynasty was the mythic period. **The Mythic Period.** the only notices of which in the legends preserved by the priests of Heliopolis and Thebes present a tangle of solar myth and hero-worship from which it is impossible to extract any historical thread. There are gods many, and demi-gods, in whom, perhaps, we may discover a faint shadow of powerful rulers or teachers of the people. As with other primitive races, there was a conception of a great Divinity, the origin of all things; and the sun, at first the symbol of an illimitable power and the life-giver to organic nature, became, in the course of time, the object of worship. It was personified as Har, or Haronachis, the rising sun, Ra, the midday, and Tum, the setting sun. In the day the divine Sun floated in a boat through **Solar worship.** the sky; at night he descended to the regions of darkness. Memphis and Thebes had each a different mythology, continually varying in persons; but practically the chief divinity appears to have been Osiris, the representative of good and the conqueror of Typhon, the principle of evil; his wife Isis, and their son Horus. These and other gods were, according to the legends, the immediate lords and lawgivers of Egypt for many thousand years; and then the power was delegated to demi-gods, or great heroes, who had divinity conferred upon them. **The Egyptian mythology.** Comparative mythologists find scope enough for their ingenuity in deriving the later Greek mythology from the Egyptian; and, indeed, there appears to be an obvious connexion, but this is not the place to enter on the subject. The Egyptians appear to have recognised a period of directly Divine government; then a heroic age, or the time of the demi-gods; and lastly, a succession of mortal kings. As with the Greeks, there were impersonations of the operations and phenomena of nature; the daily rising and setting of the sun, the movements of the moon and stars, and the annual rise of the Nile, which renewed the vegetation of the earth, contributed materials for the formation of a popular mythology. Innumerable as were the minor divinities, the great gods were arranged in triads, varying in different localities. At Memphis, they were Ptah, the demiurgos, or great worker, who created the material world; his wife, Merenphtah; and his son Nefer-Atum. At Heliopolis, the triad consisted of Tum, the sun-god, Nebhetp, and Horus; at Abydos (Upper Egypt), of Osiris, Isis, and Horus; and at Elephantine, Khnum or Chnoumis (the creator of the human race), Anuka or Anoucis, his wife, and their son Hak. Thebes had Amen Ra (equivalent to the Greek Zeus and the Roman Jupiter) for the chief god, and at a later period Mentu, the sun-god, and Horus, whose wife, Athor, was the Egyptian Venus. All these were esteemed as gods of the first order; and twelve others rank as of the second order, among whom the most eminent were Thoth, the god of wisdom and knowledge, inventor of speech and writing

ISIS AND HORUS.



TRIAD OF EGYPTIAN DIVINITIES.

and of the arts, sciences, and literature; and Anup or Anubis, the son of Osiris, who especially superintended the embalmment and burial of the dead. The minor deities were literally innumerable: every month and every day were consecrated to a divinity, and cities and rivers had their genii or divinities.

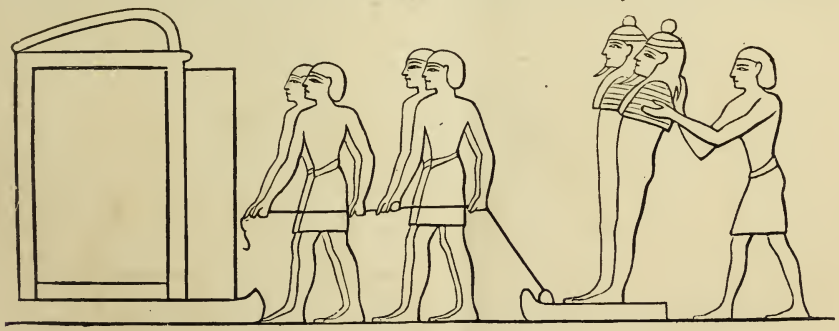
A theory of transmigration appears to have mingled with the mythological appreciation of natural phenomena. Certain animals were regarded as sacred, as incarnations of the "afflatus" or spirit of the gods. The bull (Apis) was the emblem of the moon (perhaps from the semicircular curve of the horns), and also of the creative god Ptah, and, at Heliopolis, of the sun. This appears to have been the most sacred of all animals; and the golden calf of the Israelites was an attempt to reproduce the bull, which had been known in Egypt as the object of general worship. The crocodile, the cat, the ibis—indeed, almost every familiar animal—was selected as a representative of some local deity, and maintained in the temples as the recipient of worship, the bodies, after death, being embalmed and interred with great ceremony. On the monuments many of the deities are represented with the heads of animals. The sun-gods had the heads of hawks; Thoth, the great teacher, that of an ibis; Khnum, of a ram; Anubis, of a jackal; Merenphtah, wife of the Ptah of Memphis, was lion-headed. In some instances the human head is surmounted by the representation of an animal, frequently a snake. The human-headed deities were usually distinguished by the head-dress.

APIS, THE SACRED BULL.

shrouded under hieroglyphical representations popularly accepted as verities. A few great principles appear to be revealed; among them the existence of a supreme God (however veiled under many forms), the immortality of the soul, moral responsibility, a judgment after death, and a resurrection with a reunion of the soul and body. It is not likely that all the mysteries of this complicated mythology will ever be revealed to modern inquirers; but one or two established facts are very suggestive. We have seen that the supreme deities were generally grouped in triads, including a father and a son; and it is also remarkable that, in the words of a modern writer on the subject, "some of the gods were self-existent, others emanated from a father, and some were born of a mother only."

Accepting the most probable of the chronologies, the first historic dynasty—that which, according to the native records, was the beginning of the reigns of the mortal kings—was established about 3000 B.C. There is a very abrupt transition in the legends from the heroic age, or that of the demi-gods, to that of Mena (the Menes of the Greeks), the first of the mortal kings. One writer observes: "The latest portion of the first may be traditional, not mythological, and the earliest part of the second may be traditional and not historical. In any case, there is a very short and extremely obscure time of tradition, and at no great distance from the earliest date at which it can be held to end, we come upon the clear light of history, in the

The first dynasty.



ANCIENT EGYPTIANS BURYING THE DEAD.

Osiris wears a conical cap placed on horns, with ostrich feathers at the sides; Amen-Ra, a red cap, disk, and two plumes of hawks' feathers.

Probably this strange and complicated mythology was the attempt to explain the great forces of creation and the origin of life, especially of human generation. The priestly initiations into mysteries perhaps preserved the knowledge of truths which the initiated were not permitted to reveal, and which they

days of the pyramids. The indications are of a sudden change of seat, and the settlement in Egypt of a civilized race which, either wishing to be believed autochthonous, or having lost all ties that could keep up the traditions of its first dwelling-place, filled up the commencement of its history with materials drawn from mythology."

Mena, or Menes (to adopt the most familiar form of the name), may have been the leader of a new band of settlers, numerous and

strong enough to become predominant among the peaceful cultivators of the soil, and to establish a regular form of government; or he may have been a man of superior energy and ability, who by force of character raised himself to the regal position. Tradition states that he derived his wisdom directly from Thoth, the great divine instructor, that he established laws and rites of worship, and introduced a more refined civilization than that possessed by the inhabitants of the Delta plains. He founded Men-nefer ("the good port") or Memphis, the oldest of Egyptian cities, and constructed the dyke of Cocheiche, still to be seen near Cairo. This dyke, rising three feet above the level reached by the Nile in its average annual rise, diverted the course of the branch of the river, leaving a site protected from inundation, on which the king built the fortified town, and a great temple dedicated to Ptah. In later times, the Coptic inhabitants of Egypt gave the name of Memfi to the old town; and now there are ruins surrounded by squalid villages, known as Tel-monf, in which we may have a corruption of the ancient name. A considerable amount of materials from the remains of the old Memphis were used in building the town of Cairo, in the eleventh or twelfth century. Menes was a warrior as well as a lawgiver, and undertook military expeditions against the tribes occupying the borders of the great Libyan desert. Like other warlike monarchs, he was a mighty hunter, and at last was killed either by a crocodile or a hippopotamus. So much, at least, is indicated by the traditions preserved by the priests; but some modern investigators entertain doubts of his existence, Dr. Birch going so far as to say, "He must be ranked amongst those founders of monarchies whose personal existence a severe and enlightened criticism doubts or denies." It is impossible, however, to test the veracity, in this respect, of the priestly historians. Mere negations, unsupported by evidence, go for little; and perhaps our best course is to "tell the story as it is told to us," without attempting minute criticisms. There are no monuments or inscriptions of a date anterior to the close of the third dynasty of Manetho's record; and without their aid it is impossible to supersede tradition by more authentic history. That his actual existence was believed in by Egyptians of a later date is evident; for in the great temple at Thebes is a representation, certainly 1,500 years later than the conjectural date of the reign of Menes, in which his statue appears (named in hieroglyphics) borne in procession as the first of the ancestors of the great king Rameses.

Athothis or Atahutis, the son of Menes, is recorded to have built the royal palace at Memphis, and to have been the author of a work on human anatomy, a subject which appears to have been studied with some interest by the learned men of the time; and some treatises on the healing art, now preserved in European collections, profess to have been the work of some of the early kings. Athothis was succeeded by another king of the same name; and after him came a monarch whose Egyptian name is not preserved, but who appears in the Greek lists as Ouenephes. In his reign was built the first of the pyramids, the oldest of all the Egyptian monuments, and which still exists at Sakkarah, near the site of the Egyptian Ko, or Kochome ("town of the black bull"). This is the earliest instance of which we have any record of the pyramidal sepulchres of royalty, which afterwards attained such colossal proportions as to rank among the wonders of the world. This pyramid of Ko had a base of about 395 feet square, and was 196 feet high. In the interior was the royal sarcophagus, which has been discovered in modern times.

It is unnecessary to enumerate all the eight kings named in the first dynasty. Except traditions of a famine and a plague, we are without information as to the events of their reigns. They are described as Thinite monarchs, or belonging to the kingdom of This, mentioned previously; and this would seem to favour the idea that this portion of the country was conquered by warriors of the Thinite race, of whom probably Menes was the leader. The second dynasty is also described as Thinite; probably there was some break in the direct line of succession after the death of the eighth king, and the new sovereign was therefore considered as the founder of a new dynasty.

The second dynasty.

There are notices of some remarkable events said to have occurred during the reigns of this second race of kings, among them an earthquake, which destroyed many lives in the town of Bubastis, on one of the eastern of the Nile channels. The second king, Kakau, instituted the worship of animals, especially of the bull Apis, at Memphis. To his successor, Binothris, or Baienneter, was due a very marked innovation—a law that the crown might be transmitted in the female line. The fifth king of the line, Sethenes or Sent, received public adoration and worship; and his successors frequently added Ra, a name of the sun-god, to their own names. There were nine or ten kings of this dynasty, the last but one being Sesochris, or Neferka-Sekar, said to have been of gigantic stature, about ten feet high and broad in proportion.

Political and social condition.

This dynasty, the third, was succeeded by another, of nine kings, known as the Memphite, but we are left to conjecture the events which may have resulted in the transfer of the kingly power; and it may be convenient to pause here, and by the aid of the traditions preserved to later times, and the monuments, erected at a later date but preserving some of the earlier annals, endeavour to collect a few particulars respecting the political and social condition of the country.

The people, numbering probably six or seven millions, were divided into five classes or castes, not with indelible limits, like those of the Hindūs, but sufficiently distinct to prevent much mingling.

The first class comprised the priests, of whom were several grades, varying in influence according to the rank of the gods in whose temples they served. All the chief offices of state were occupied by members of the priestly

caste. They were the depositaries of religious traditions, and expounders of the law, judges. physicians and architects. They had the custody of the sacred records, and practised a mode of writing peculiar to themselves. Candidates for the priesthood were required to pass through mysterious forms of initiation, popularly believed to be of a very terrible character ; and this ceremony of initiation the king himself was compelled to undergo, if he did not previously belong to the priestly caste. The king was solemnly bound to govern according to the laws as expounded by the priests, who were exempt from all imposts such as were levied on others, and received a maintenance from the state.

The second class were the warriors—for a standing army appears to have existed in the earliest times of the monarchy. It was divided into battalions or regiments, each having a peculiar emblem, and every soldier had a portion of public land allotted to him for his support.

The third class was composed of cultivators of the soil, who may be supposed to have formed the greater portion of the population—which, in modern language, we might describe as the great middle-class.

BOTANY.

XXVIII.

The Classification of Plants.

Allusion has many times been made to botanical "families." We now proceed to describe exactly what these are, and upon what principles botanists have proceeded in constructing them. It is proper, however, to sketch, in the first place, the early history of classification, thus enabling ourselves to follow, step by step, the admirable discoveries of which the idea of the families may be considered the outcome and result. In the earliest ages, say in the time of the Greeks and Romans, when plants were regarded merely with a view to their utilization, and the number which had been discriminated scarcely exceeded a thousand, the efforts at classification were of the very simplest kind, and scarcely deserved the name. Trees, shrubs, aromatic herbs, poisonous plants, and a few other such groups were established; but upon points of likeness wholly superficial, and seldom of the slightest scientific value. Botany, in truth, had not commenced, and the system of arrangement was conjectural and quite arbitrary. Such was the state in which it existed, indeed, at the time of the restoration of learning, in the fifteenth century, to which period all exact knowledge of plants must be referred for its beginning. Most curious and interesting is the illustration, in the botanical patriarchs of that time, of the zest with which a proper system of classification was sought and not found. None of the early workers went deep enough. As in so many other things, there was too great a disposition to rest content with the surface, and with appearances, whereas truth, like the gold and diamonds hidden in the mine, invariably calls for a certain amount of digging and sifting. In the ages commonly called those of Shakspeare and his immediate predecessors, ingenious and patient observers of plants thought to classify them by the peculiarities, simply and sufficiently, of their flowers, their fruits or seed-pods, and even their leaves. There were distinct perceptions, at the same time, of genuine resemblances; so that in the old "herbals" we often find plants very correctly and consistently side by side. Still there was no settled principle at work, and for want of it the most amusing errors were constantly made. Light began to dawn with the observation that the affinities of plants depend not upon resemblances between the flowers alone, or the leaves alone, but upon similarities of the entire series of organs, and in very many cases upon resemblances of parts not patent to the first view. How grand the discovery that the structure of the seed must never be skipped! Equally fine, in regard to real scientific classification, was the discovery that the internal structure of the stem must be taken account of,—that also of the leaves, at all events as regards their venation. The result of thousands of careful comparisons, and of persevering, minute scrutiny, was that plants began to be cast into the great natural groups which to-day we call families, only that very many were rebellious, and had to be let remain, as it were, outside. This, in truth, is a difficulty which has never yet been wholly grasped. Many plants, at this present moment, are, as the classifiers say, of "uncertain seat." Still we know pretty nearly where to place them, and in course of time no doubt the marshalling will be complete. An illustration of the modern uncertainty as to the true relationship of even a very familiar plant is furnished by that lovely wild-flower the Parnassia. Surely, one would think, there can be no mystery over this. A simple and straightforward pentamerous white blossom, stamens and pistil well developed, would seem the last thing to be perplexed over. Yet that charming flower has been regarded by different good botanists, and for well-considered reasons, a member of the St. John's wort family, of the Sundew family, and of the Saxifrage family, in which last-named it now rests. With the growth of clearer ideas as to the real bases of plant-affinity, there was increase in the knowledge of species. Botanists are of two distinct classes. Some love the philosophy of plants, the laws of their life, and the information supplied by the study of a comparatively small number. Others are enamoured of the pleasures attending the discovery of the new and strange, and without disregarding physiology, prefer to ramble over the hills and far away, in search of surprises and additions to the list of the plants growing at home. The latter spirit was never more active than during the childhood of Botany. The Alps, the Pyrenees, the forests and plains of every accessible part of Europe

were explored, with the result to be expected, —an enlargement, to the extent of several thousands, of the list of species known to the ancients. This steady augmentation of the mass of material to be dealt with caused still profounder embarrassment with the classifiers; and by the close of the seventeenth century, despite the brilliant achievements, particularly of the German botanists, in respect of sound classification, the detail was fast becoming unmanageable. Early in the eighteenth century a happy change came to pass. Then arose, at Upsala in Sweden, a botanical genius by whom an expedient was devised for classifying plants in such a way that there should be a place not only for every species already known, but for everything that nature can possibly contain. This great man was Linnæus, ever since that period venerated as the father of botanical order and exactitude. His plan was to defer for awhile the marshalling by pure affinities, and to fall back upon plain and palpable resemblances, such as readily catch the eye, and serve the excellent temporary purpose, just then required so urgently, of enabling all things to be sorted and ticketed, and put where every one could find them. Linnæus commenced, towards this great end, in a way intelligible to a child. He counted the stamens and pistils, observed in what manner they were placed, and the other particulars above mentioned as remarkable in these organs; then threw the whole mass of flowering-plants into twenty-three classes, and adding a twenty-fourth for the Cryptogamia, the scheme was complete. It so happens, as we have indicated in former chapters, that in a few large families of plants there is an almost absolute uniformity as to the number and arrangement of the stamens and pistils. The Cruciferæ, for instance, are always tetradynamous, the Malvaceæ always monadelphous, the Orchidaceæ always gynandrous. Hence there was now and then, in the Linnæan system, a coincidence of natural and artificial. But most of the classes were as heterogeneous as any of those constructed by the Greeks and Romans. Having regard to the purpose in view—a ready and unexceptionable mode of classifying, open to the comprehension of all men—the heterogeneousness did not matter. The object was attained, and that was enough. The Linnæan system of twenty-four classes at once gave new life to Botany. Every student of it took heart; and however rapidly new plants poured in from foreign countries, there was a niche for them on the instant.

FIG. 168.—EDIBLE MUSHROOM (*Agaricus campestris*). *See* pp. 17, 18.

Unspeakably valuable as was the method of arrangement devised by Linnæus, he rendered a still greater service to botany in giving definiteness to the ideas expressed in the words "genus" and "species." So far he worked on behalf of what to-day we call the "Natural System," and the accuracy of his judgment and performances is declared by the recognition to this day of the great majority of the genera and species he discriminated and described. A "genus" of plants is a collection of kinds related to one another, and usually resembling one another, in the way that is familiarly illustrated, say, in peas.

Genera and species.

We have first the fragrant "sweet pea" of the flower-garden; then the scentless "everlasting pea," which produces its fine rosy crimson clusters in the hedgerows, and again in the garden; then the "yellow field-pea," an abundant element of many a meadow; and besides these a score of others, less common, but well known to cultivators of the pretty and curious. The Tangier pea, the blue-flowered pea, the seaside pink-flowered pea, the marsh pea, furnish examples. These, in the aggregate, constitute the genus called in Latin *Lathyrus*, every one of the different kinds being, at the same moment, a "species." The definition of a "species" is, no doubt, according to the views of modern science, a matter scarcely yet within command. Ever since the publication of Mr. Charles Darwin's celebrated book on "The Origin of Species," the old idea of their fixedness and their original integrity has required qualification. It is sufficient, however, for all ordinary, straightforward, practical purposes, that we accept the idea of "species" as laid down by Linnæus. It is quite enough for plain, common-sense people that the plants around us keep the same from seed, year after year, always reproducing themselves after the same identical fashion that they did centuries ago, as proved by the drawings and descriptions in the old herbals of the time of Henry VIII. and Queen Elizabeth. The seedlings sport and vary, no doubt, in regard to the colours of the flowers, and other subordinate and unimportant particulars, but the essential characters remain the same. The Pansy, the Dahlia, the Tulip, are the same in all that really constitutes them what they are, no matter how strange, as well as exquisite, the departure in matter of hue of the petals, which is but transitory. "Genera" are, in some respects, more arbitrary. Whether we yet

understand the true principles upon which "species" should be grouped, is still uncertain. Botanists very frequently refer the same species to different genera; and some are disposed to reduce the number of genera very considerably, as done by Mr. Bentham and Dr. Hooper in the splendid work upon which they have now been engaged for nearly twenty years. It remains true, nevertheless, that for ordinary people, who desire to enjoy things as they are, somehow the Linnæan idea of a genus holds good and unchanged to the present day. Every one can understand what a Lilium is, or a Primula, or a Quercus, or a Salix. The whole matter of classification depends very much upon men's own intellectual temperament. Those who are fond of tracing the magnificent unities of nature throw things together more, reducing the number alike of families, genera, and species. Those who have quick eyes for minute differences, and who attach equal value to the trivial and the substantial, multiply the number of all three. As in other things, the truth lies, no doubt, in the "happy medium." The multiplying of "species" by the analytical-minded is remarkably illustrated in the number of names bestowed upon the forms of that protean plant, the water snow-cups, *Ranunculus aquatilis*, which has been subdivided into a score or two. In English botany there has been a similar multiplying of the "species" of the common Hawkweed, *Hieracium murorum;* and the names of many other plants might be cited to the same purpose.

FIG. 169.—COMMON MUSHROOM.

FIG. 171.—MORELL.

FIG. 170.—CHAMPIGNON.

FIG. 172.—POISONOUS FUNGI.

XXIX.

The Comparison of Adjectives.

In English the comparative and the superlative degree of adjectives are expressed respectively by adding *er* and *est* to the positive—as old, older, oldest; but in many dissyllabic and all polysyllabic words by prefixing the words *more* and *most* to the adjectives. In German the mode of proceeding is similar: the comparison is formed by adding **er** and the superlative by adding **eſt** to the uninflected form of the positive, quite irrespective of the number of syllables the word may contain. Thus, if the adjective is in an inflected or declined form, the **er** and **eſt** (the latter generally shortened into **ſt**) will come before the inflexion, as in the following examples:

Das kleine Buch, the little book; **das kleinere Buch**, the smaller book; **das kleinſte Buch**, the smallest book. **Des werthen** (*vairr'-ten*) **Männes**, of the worthy man; **Des wertheren Mannes**, of the worthier man; **Des werthſten Mannes**, of the worthiest man. Where the adjective ends in **d**, **ſ**, **ſch**, **ſt**, **ß**, or **z**, the full **eſt** is used.

Many adjectives, especially those in **el**, **en**, **er**, omit the **e** in the comparative—as **dunkel**, dark; **dunkler**, darker.

Generally, monosyllabic adjectives have the **Umlaut** or modification of the vowels *a*, *o*, and *u*, changing these into **ä**, **ö**, and **ü**—as **Die alte Frau, die ältere, die älteſte Frau**, the old woman, etc. But there are many exceptions. The following, among others, retain the vowel unaltered:—

Barſch, harsh, rude; **blank**, bright, shining (metallic); **brav**, good; **blaß**, pale; **bunt**, variegated; **dumpf**, dull (generally of sound); **fahl**, fallow; **fade**, insipid; **falſch**, false; **flach**, flat; **froh**, glad; **gerade**, straight; **glatt**, smooth; **hohl**, hollow; **hold**, fair, gentle; **kahl**, bald; **karg**, stingy; **knapp**, tight; **lahm**, lame; **laß**, tired; **loſe**, loose; **matt**, wearied; **morſch**, brittle, rotten; **nackt**, naked; **platt**, flat; **plump**, clumsy; **raſch**, quick; **roh**, raw; **rund**, round; **ſacht**, slow, soft; **ſanft**, gentle; **ſatt**, satisfied, sated; **ſchlaff**, slack; **ſchlank**, slender; **ſchroff**, rugged; **ſtarr**, stiff; **ſtolz**, proud; **ſtraff**, tight; **ſtumm**, dumb; **ſtumpf**, blunt; **toll**, mad; **voll**, full; **wahr**, true; **zahm**, tame.

(The foregoing adjectives should be learnt by heart, as they frequently occur, that they may be recognised, and always used in comparative and superlative *without* the **Umlaut**, thus—**barſch, barſcher, ſtolz, ſtolzer**, etc.)

In English the word "most" is frequently used in the meaning "exceedingly." In German we use the expression **höchſt** (in the highest degree) or **äußerſt** in such a case, and call it the superlative of eminence. Thus: He is a most worthy man, would be—**Er iſt ein höchſt**, or **äußerſt würdiger Mann.**

When one adjective is compared with another with regard to the same subject, and when, therefore, the English word "more" would be synonymous with "rather," as in the phrase He is more (rather) industrious than clever, the word "more" is rendered by **mehr: Er iſt mehr fleißig als geſchickt.** The corresponding superlative is **am meiſten**, or **am mehrſten.** For instance: He is most known through his

pictures, Er iſt am meiſten durch ſeine Bilder bekannt. In the same manner "less" and "least" are expressed by weniger or minder, less, and am wenigſten or am mindeſten, least: Er iſt weniger glücklich als ich, he is less happy than I.

The following adjectives are irregular in their comparison:—

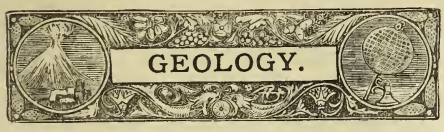
hoch, high	höher, higher	höchſt, highest
hoach (the *oa* as in "oath")	*höh'-er*	*hoechst*
nahe, near	näher, nearer	nächſt, nearest
nah'-e	*nay'-er*	*naychst*
gut, good	beſſer, better	beſt, best
goot	*bes'-ser*	*best*
viel, mueh	mehr, more	meiſt, most
feel	*mairr*	*myste*
groß, great	größer, greater	größt, greatest
gross	*groes-ser*	*grocst*

Study on the Comparison of Adjectives.

(Remember to insert the signs of the comparative and superlative, the er and eſt or r and ſt, *before* the inflexional termination, thus: Dem braven Manne, dem braveren Manne, dem bravſten Manne. The adjective in the comparative or superlative degree is therefore declined exactly as in the positive, the degree of comparison not interfering with the declension, as the er and the ſt do not appear at the end of the word except where the adjective is undeclined, as—Das Kind iſt kleiner, the child is smaller. Here the adjective is undeclined, as a predicate, after the verb ſeyn, to be.)

Ein ruhiges Leben iſt beſſer als Gold
ine roo'-ich-es lay'-ben ist bes-ser als golt
und Silber. Der Kaiſer Karl der Große
unt zil'-ber dare ky'-zer karrl dare gross'-se
war ein viel beſſerer Mann als ſein Sohn
vahr ine feel bes'-ser-er mann als zine zone
Ludwig der Fromme; auch regierte er
lood'-vich dare from'-me owch re-geer'-te airr
länger. Heinrich der Löwe, Herzog
laeng'-er hine'-rich dare loe'-ve hairr-tzoch
von Sachſen, war der mächtigſte der
fon zaeh'-sen vahr dare meeh'-tich-ste dare
Vaſallen des Deutſchen Kaiſers; keiner
vah'-sal'-len des doit'-shen ky'-zers ky'-ner
war größer oder reicher als er.
vahr groes'-ser oh'-der ry'-cher als airr
„Hunger iſt der beſte Koch," ſagt das alte
hung'-er ist dare best'e koch zaacht dass al'-te
Sprichwort. „Der ſchwerſte Stab im Land,"
sprich'-vort dare shvair'-ste stahb im land
ſagt ein anderes Sprichwort, „iſt der
zaacht ine an'-der-es sprich'-vort ist dare
Stecken in des Bettlers Hand." Der Narr
steek'-en in des bett'-ler's hand dare nahrr
gleicht dem Weiſen am meiſten, wenn er
glycht dame vy'-zen am my'-sten venn airr
ſtatt zu reden, ſchweigt. Dresden iſt
statt tsoo ray'-den shvycht drays'-den ist
eine der ſchönſten unter den Deutſchen
i'-ne dare shoen'-sten un'-ter dane doit'-shen
Hauptſtädten; keine Stadt zeigt größere
howpt'-stay'-ten ky'-ne stat tsycht groe'-se-re
oder zahlreichere Kunſtwerke als
oh'-der tsahl'-ry-che-re kunst'-wairr-ke als
man hier in der berühmten Bilder-
man here in dare be-ruehm'-ten bil'-der-
gallerie findet. Auch die Kirchen und
gal-ie-ree' fin'-det owch dee keer'-chen unt
andere Gebäude ſind äußerſt prachtvoll.
an'-de-re ge-boy'-de zint oy'-serst pracht'-foll
Nicht weit von einem großen Steine den
nicht vite fon i'-nem grow'-sen sty'-ne dane
man nachher als Denkmal aufrichtete,
man nach-hare' als denk'-mahl orf'-rich-te-te
fiel der tapfere, kluge, König Guſtav
feel dare tap'-fe-re kloo'-ehe koe'-nich gus'-taf
Adolf auf der berühmten Lützener
ah'-dolf orff dare be-ruehm'-ten luet'-sen-er
Ebene. Die Trajans-ſäule zu Rom
ay'-be-ne dee trah-jahns'-zoy'-le tsoo rome
wurde als Denkmal der großen Siege
voor'-de als denk'-mahl dare gross'-en zee'-ge
errichtet die der kräftige Trajan
er-rich'-tet dee dare kreff'-tiche trah-jahn'
über die kriegeriſchen Dacier gewann.
ue'-ber dee kree'-ge-rish-en daht'-see-er ge-vann'
Nach der friedlichen und glücklichen
naach dare freed'-lich-en unt glück'-lich-en
Regierung des Antoninus Pius, folgte
ray-geer'-ung des an-to-ni'-nus pee'-us folg'-te
Marcus Aurelius, der weiſe Philo-
mar'-cus ow-ray'-le-us dare vy'-ze fee-low-
ſoph, gleich ausgezeichnet als Regent,
zoaph' glych ows'-ge-tsych'-net als ray-ghent'
und als Feldherr. Am frühen Morgen
unt als felt'-hairr am frue'-en morr'-gen
ſind die Gedanken am klarſten; der
zint dee ge-dank'-en am klahr'-sten dare
Geiſt iſt hell, und am fähigſten harte
guyst ist hell unt am fay'-ich-sten harr'-te
Arbeit zu vollenden. Der Undank iſt
arr'-bite tsoo vol-len'-den dare un'-dank ist
eins der ſchlimmſten Laſter. Im Winter,
i'-nes dare shlimm'-sten last'-er im vinn'-ter
in Holland ſieht man ein luſtiges
in hol'-land zeet man ine lust'-ich-es
Leben auf den gefrorenen Flüſſen
lay'-ben orff dane ge-froar'-en-en fluess'-en
und Kanälen, wann die Leute auf raſchen
unt kah-nail'-en vann dee loy'-te orff rash'-en
Schlittſchuhen vorbei jagen. Das Schwert iſt
shlitt'-shoe-en for-by' yah'-gen dass shvairt ist
dem freien Manne als letztes Mittel
dame fry'-en man'-ne als lets'-tes mit'-tel
gegeben. Das Leben iſt kurz aber
ge-gay'-ben dass lay'-ben ist koorts ah'-ber
die Kunſt iſt lang. Vor vielen hundert
dee kunst ist lang fore feel'-en hund'-ert
Jahren war die Stadt Stavoren, an der
yah'-ren vahr dee shtat stah-vohr'-en an dare
Holländiſchen Küſte, groß und reich, und
hol'-len-dish-en kuest'-e gross unt ryeh unt
trieb einen anſehnlichen Handel mit
treeb i'-nen an'-zayn-lich-en han-del mit
fremden Ländern; aber jetzt iſt ſelbſt
frem'-den lend'-ern ah'-berr yetst ist zelbst

der Name beinahe vergessen. „Rede wenig, rede wahr, brauche wenig, zahle bahr," ist ein sehr nützlicher Spruch.
dare nah'-me by-nah'-e fer-ges'-sen ray'-de vay'-nich ray'-de vahr, brow'-che vay'-nich tsah'-le bahr ist ine zair nuets'-lich-er spruch



XXII.

Tertiary Period—Eocene Series (*continued*).

The whole of the Middle Eocene series are best exhibited in the Hampshire basin, the Lower Bagshot beds being exposed in Alum and Whitecliff Bays, in the Isle of Wight. At Alum Bay the sands are unfossiliferous, but the clays are rich in plant-remains of a tropical or sub-tropical character. Similar remains are found at Bournemouth, Studland, Poole, and Corfe. Mr. Starkie Gardner, who has given much attention to these deposits, says that from "Studland to a mile east of Bournemouth they are purely fresh-water delta deposits. They are then overlaid by marine and brackish delta mud, by shingle and sand, and by a sequence of marine strata at Hengistbury Head. This series," he adds, "is particularly interesting, as in it we can trace step by step one of the numerous subsidences which took place in Eocene times. The flora shows a gradual change from upland character to valley and to swamp; then lagoon conditions are traced, shingle and sea-sand, and finally open sea deposits. A noteworthy fact is that in the marine beds we have fruits, which, although comparatively few in number, are important because similar to or identical with those from Sheppey." The *Barton clay* and the *Bracklesham beds* are very commonly regarded as forming a middle series of the Bagshot beds. Both these formations in the localities whence they derive their names are very fossiliferous, and the Bracklesham beds at Alum Bay, consisting of clays and marls overlaid by coloured sands, contain some notable deposits of lignite. Nearly 400 species of molluscs, a sea-serpent, a crocodile, and numerous fish, have been obtained from the Bracklesham beds of this country. They also contain many foraminifera of the genus *nummulites*, common in and characteristic of Middle Tertiary deposits throughout the world. The *Barton clay* is equally rich in fossils, which, however, are suggestive of more temperate conditions. The *Upper Bagshot sands* are from 140 to 200 feet thick in the Isle of Wight, where they are worked for the manufacture of glass; and they are well shown in the London basin, on Frimley and Chobham Ridges, on Bagshot Heath, and at Hatford Bridge and Sandhurst.

Bagshot beds in the Isle of Wight.

The exact position in the geological scale of the Headon, Osborne, Bembridge, and Hempstead beds of the Isle of Wight can scarcely be said to have been accurately determined. They are of later date than the strata described above; and for convenience we have followed Sir Charles Lyell in classifying the three first-named as Upper Eocene, though many geologists, following Professor Judd, are disposed to call them "Oligocene," believing them to be the equivalents of strata so designated on the Continent, and recognized as coming between the Upper Eocene and the Miocene. The Geological Survey include the Headon and Osborne beds with the Middle Eocene. The *Headon beds* are green shelly sands and limestones. At Headon Hill they measure about 133 feet in thickness, and at Whitecliff Bay 175 feet. They contain land, fresh-water, estuarine, and marine shells, with seed-vessels, etc., of the chara, and other vegetation. Deposits of the same age at Hordwell Cliff have yielded remains of several birds, and various quadrupeds, including *Palæotherium*, *Anoplotherium*, *Dichodon*, *Dichobune*, *Spalacodon*, and *Hyænodon*. These deposits have also supplied remains of land-snakes, crocodiles, turtles and fish. The *Osborne beds* are about 100 feet thick, and are very variable in character. They have been divided into the *St. Helens' sands* and the *Nettlestone grits;* the former consisting of sands with marls and clays, the latter of grit, soft sandstone, clay and limestone. The fossils are principally fresh-water in character. The *Bembridge beds* consist of marls, clays and limestones of fresh-water, brackish, and marine character, and have a total thickness of about 120 feet. The fossils are land, fresh-water, estuarine, and marine shells, with mammalian and reptilian remains, including *Palæotheria*, *Anoplotheria*, etc.; insect remains and plants are also found. Marine strata at Brockenhurst, in the New Forest, believed to be the equivalents of the Middle Headon beds, have furnished a considerable number of corals as well as shells.

The fluvio-marine strata of the Hampshire basin.

The Headon beds.

Osborne beds.

Bembridge beds.

The Paris basin, which is also a shallow synclinal curve in the chalk, contains a similar group of Eocene strata to that which is represented in the London and Hampshire basins, though some difficulty is experienced in attempting to correlate the various subdivisions of the English and French deposits.

Miocene.

The Miocene deposits of Great Britain are comparatively insignificant, even if we include the *Hempstead beds* (Isle of Wight). These are mostly fresh-water and estuarine marls, with a thin bed at the top containing marine fossils, and having a total thickness of between 160 and 170 feet. The characteristic shells of the upper (marine) bed are *Corbula pisum*, *Cyrene semistriata*, *Voluta Rathieri*, etc. The beds below these contain numerous fresh and brackish water shells. The most common mammalian remains

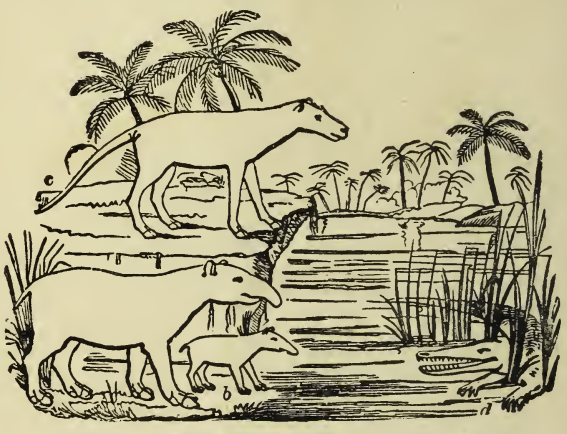
The Miocene strata of Great Britain.

Hempstead.

are those of a hog-like animal, the *Hyopotamus*, of which there are two species found in these beds. Among the plants four species, found also at Bovey Tracey, have been identified by Professor Heer.

The *Bovey Tracey* lignite beds have been long known and worked, near Bovey Tracey, in Devonshire. They are supposed to be from 200 to 300 feet in thickness, and extend over a plain about nine miles in length. They are believed to have been deposited in an ancient lake, and laid down at the same time as the clays which are worked near Kingsteignton and Newton Abbot. "From Dr. Heer's investigations it seems that the woods covering the slopes which surrounded the old lake, consisted of a coniferous tree (*Sequoia Coutssiæ*), whose figure resembled, in all probability, its highly admired cousin the *Sequoia* (*Wellingtonia*) *gigantea* of California. The leafy trees of most frequent occurrence were the cinnamons, and an evergreen oak like those which are now seen in Mexico. Species of evergreen fig were rarer. The trees of the ancient forest were evidently festooned with vines, beside which the prickly Rotang palm twined its snake-like form. In the shade of the forest throve numerous ferns; one species of *Pecopteris* seems to have formed trees of imposing grandeur, while on the surface of the lake were expanded leaves of the water-lily." (H. B. Woodward.)

Bovey Tracey.



ANOPLOTHERIUM COMMUNE; PALÆOTHERIUM MAGNUM AND MINUS; AND CROCODILE.

On the western coast of the island of Mull, in the Hebrides, leaf-beds interstratified with volcanic tuff and trap have been described by the Duke of Argyll and identified as being probably Miocene in age. Similar beds occur in Antrim, associated with the basalt which there overlies the chalk; and these have been in a similar manner, and upon like ground, regarded as lacustrine deposits belonging to the Miocene period. In several places thick beds of lignite occur interstratified with the basalt.

Scotch and Irish deposits.

Eocene strata occur in the United States over a large area, and within the last few years have yielded an immense number of fossil remains, including those of a great many mammals previously unknown.

PLIOCENE.

Referring once again to our sketch map (vol. i. p. 688), it will be seen that Tertiary strata extend along the east coast in a northerly direction as far as the Wash. The scale upon which the map has been engraved is too small to show the details, and it has been impossible to make a distinction between the Eocene deposits and the Pliocene formations, which partly overlie them, and in part rest directly upon the chalk in the eastern borders of Essex, Suffolk and Norfolk. These, with the exception possibly of some small beds in the neighbourhood of Aberdeen, are the only deposits of the period in the British Isles, and are included under the general name of the Crag. They are further divided into the

The Pliocene deposits of the east coast.

Chillesford and Aldeby beds,
Norwich (or Fluvio-Marine) Crag,
Red Crag,
Coralline Crag.

Of these the *Coralline Crag* is the oldest. It consists mainly of shelly, calcareous and sandy beds, which are sometimes hard enough to form soft building stone, and contain a large number of *bryozoa*—which, although not true corals, have yet suggested the designation "Coralline" by which they are known. In thickness these beds vary from about forty to sixty feet. The *Red Crag* consists of shelly, sandy beds, almost invariably stained with iron, and is a much more extensive deposit than the Coralline Crag. The area occupied by the Coralline Crag, as far as it is known, is about eight square miles in the neighbourhood of Orford. The Red Crag covers an area of about 300 square miles, much overlaid and hidden, however, by boulder clays and sands. It is described by Mr. Prestwich as "occupying an excavated area in the Coralline Crag, wrapping round isolated reefs of the latter, filling up the hollows between them, and lying nearly on a level with the conterminous Coralline Crag."

Coralline Crag.

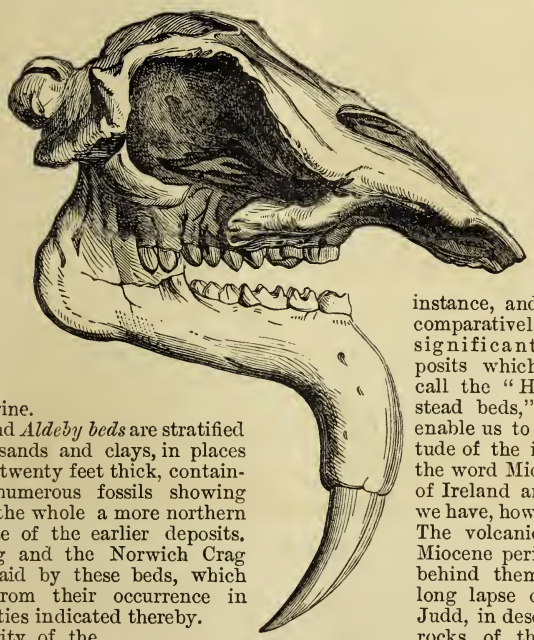
At the base of the Crag (*Coralline* and *Red*), and lying directly upon the London clay, is a "coprolite" bed composed of phosphatic nodules, and teeth and bones, more or less water-worn, of mastodon, elephant, rhinoceros, bear, tapir, hog, cervus, hipparion, horse, hyæna, beaver, walrus, whale, shark, etc., etc. That some of these fossils and others not included in the list are "derived," there can be no doubt; but how many of them are of that character is not so easily determined. Some have been washed out of the London clay, and some are traceable to older formations; others have been apparently derived from beds known in Belgium as Diestien

The Coprolite beds of the Crag.

or Black Crag, and many shells and other fossils contained in the Red Crag have been obtained from the Coralline Crag, which was much wasted when the later beds were being laid down. The average thickness of the Red Crag is about twenty-five feet. It is well exhibited at Walton-on-the-Naze, Sutton, Ramsholt, etc.; and near Aldborough, and at Park Farm, near Tattingstone, it is to be seen overlying the Coralline Crag.

Norwich Crag.

The *Norwich Crag*, which is believed to be of the same age as the upper part of the Red Crag, was probably deposited in an area separated from the Red Crag sea by a land barrier. It receives its name from its occurrence near Norwich, and consists of patches of incoherent sand, loam, and gravel, rarely exceeding twenty feet in thickness. At their junction with the chalk below a "stone bed" invariably occurs, containing numerous unrolled flints, and many mammalian remains, including those of mastodon, hippopotamus, rhinoceros, cervus, horse, etc., etc. The shells of the Norwich Crag are a mixture of land, fresh-water and marine.



SKULL OF DINOTHERIUM (*Miocene*).

Chillesford and Aldeby beds.

The *Chillesford* and *Aldeby beds* are stratified deposits of yellow sands and clays, in places about twenty feet thick, containing numerous fossils showing upon the whole a more northern character than those of the earlier deposits. Both the Red Crag and the Norwich Crag are in places overlaid by these beds, which take their name from their occurrence in Suffolk in the localities indicated thereby.

Fauna of the Crag.

The great majority of the shells of the Crag consist of species still living, though many of them formerly common are now rare, and others formerly rare are now abundant. In the Coralline Crag the percentage of shells not known as living is about 31·5; in the Red Crag about 25, in the Norwich or Fluvio-marine Crag about 17·5; and in the Chillesford and Aldeby beds the percentage is about 9·5.* Of the bryozoa belonging to the Coralline Crag 140 species have been registered; amongst the bivalve shells common to this formation are *Pecten opercularis, P. maximus, Pholadomya Histerna, Glycimeris angusta, Cyprina islandica, Pectunculus glycimeris, Lucina borealis, Cardita senilis, Panopea Faujasii, Terebratula grandis.* Amongst the univalves are *Cypræa Europæa, Voluta Lamberti, Turritella incrassata, Natica, Calyptræa Chinensis*, etc., etc. The fossils of the Red Crag include many of the above. A "left-handed" variety of one well-known species, *Trophon antiquum* (*Fusus contrarius*) occurs at Walton-on-the-Naze. *Cassidaria bicatenata, Buccinum Dalei, Voluta Lamberti, Natica multipunctata, Astarte Omallii, Capulus Hungaricus, Cyprina rustica, Cardium Parkinsoni*, and *Pectunculus glycimeris*, are amongst the characteristic species of this formation. The fossils of the Norwich Crag include *Litorina Litorea, Conovulus pyramidalis, Purpura lapillus, Trophon scalariforme, T. antiquum, Cerithium punctatum*, several varieties of *Tellina, Cardium edule, Mytilus edulis*, etc., etc. The Chillesford beds include *Purpura crispata, Litorina, Astarte borealis, Cyprina islandica, Mya truncata*, etc., etc.

Tertiary deposits of Great Britain comparatively insignificant.

The Tertiary strata of the British Islands do not give anything like an adequate idea of the time which they represent in geological history, or the important movements of the earth's crust associated with them. A few beds of lignite, for instance, and the comparatively insignificant deposits which we call the "Hempstead beds," do not go far to enable us to realize the magnitude of the interval covered by the word Miocene. In the north of Ireland and in the Hebrides we have, however, a better guide. The volcanic outbursts of the Miocene period have there left behind them the records of a long lapse of ages. Professor Judd, in describing the volcanic rocks of the Hebrides, says: "We are able in the case of each of the great Tertiary volcanoes, to arrive at some idea concerning the area covered by their bases. The base of the volcano of Mull must have had a circumference of at least forty miles. Etna, which has a greatly truncated form, nevertheless rises to a height of 10,900 feet from a base only thirty miles in circumference; a similar relation between the base and the altitude of the great volcanoes of Sicily and Mull would lead us to infer that the elevation of the latter was at least 14,500 feet." By an entirely different process of reasoning, Professor Judd shows that it must have reached a height of at least 10,000; and if so Beinn More, which is the highest point now left of the old volcano, must have lost by denudation at least some seven thousand feet of perpendicular height, formed of hard rock, and wasted away by the slowly operating agencies of

Volcanic rocks of the Hebrides.

* Lyell's *Student's Manual.*

nature! These and many other similar facts show, at all events, that it must be a long time since the Miocene volcanoes were in active operation.

XXIX.

Multiplication of Decimals.

Suppose we want to find the product of two decimals; for instance, 3·72 and ·5.

We have $3{\cdot}72 = \frac{372}{100}$, and $\cdot5 = \frac{5}{10}$.

The product of these fractions is $\frac{372 \times 5}{1000}$.

Therefore the product of the given decimals is a fraction whose numerator is the product of the two numbers treated as integers (the decimal point being suppressed), and whose denominator is 1 followed by as many 0's as there are decimal places in the two numbers. Now, this fraction is converted into a decimal by taking its numerator (*i.e.* the product of the two given numbers) and marking off from the right as many decimal places as there are 0's in the denominator.

Hence we have the following

Rule for the Multiplication of Decimals.

Multiply the two numbers together as if they were whole numbers (the decimal points being suppressed), and in the product thus found mark off from the right as many decimal places as there are decimal places in the two numbers.

Example 1.—Multiply ·521 by ·73.

521
73
1563
3647
·38033

The product of the numbers, treated as integers, is 38033.

Now, in the multiplicand there are three places of decimals, and in the multiplier there are two: ∴ altogether there are five places, and by the rule we must therefore cut off five places in the product, beginning from the right. So that ·521 × ·73 = ·38033.

If we wish, we can verify this result by fractions.

Thus, $\cdot521 \times \cdot73 = \frac{521}{1000} \times \frac{73}{100} = \frac{521 \times 73}{100000}$

$= \frac{38033}{100000} = \cdot38033.$

Example 2.—Find the product of ·012, ·23, and ·001.

23
12
276

∴ ·012 × ·23 = ·00276,

since there are five places of decimals in the two numbers, and ∴ we must make up, with 0's if necessary, five places of decimals in the product.

Again, 276 × 1 = 276; ∴ ·001 × ·00276 = ·00000276.

Here, in order to make up in the product the eight places which the multiplier and multiplicand have between them, we must supply five ciphers.

To verify this result by fractions, we have

$\cdot012 \times \cdot23 \times \cdot001 = \frac{12}{1000} \times \frac{23}{100} \times \frac{1}{1000}$

$= \frac{276}{100000000}$

$= \cdot00000276$

Exercises.

1. Find the following products:—

(*a*) ·32 × ·5	(*g*) 13·4 × 1·34
(*b*) ·76 × ·05	(*h*) 723 × ·01
(*c*) ·076 × ·005	(*k*) 98·2 × ·002
(*d*) ·760 × 5	(*l*) 453·001 × 1·001
(*e*) 76 × ·00050	(*m*) ·00178 × 132·1
(*f*) 134 × ·134	(*n*) ·666 × 66·6

2. (*a*) *A*, *B*, and *C* walk respectively 2·9, 3·09, and 3·17 miles per hour. How far will they walk each in 13·0172 hours?

(*b*) If a fourth man, *D*, walk as much per hour more than *C* as *C* does more than *B*, how far will *D* be in advance of *C* at the end of 11·7001 hours?

(*c*) In one shilling there is £·05. How many pounds are there in 500 shillings?

Answers.

1. (*a*) ·160; (*b*) ·038; (*c*) ·00038; (*d*) ·38; (*e*) ·038; (*f*) 17·956; (*g*) 17·956; (*h*) ·1964; (*l*) 453·454001; (*m*) ·235138; (*n*) 44·3556.

2. (*a*) *A* = 37·74988, *B* = 40·223148, *C* = 41·264524; (*b*) ·936008 miles; (*c*) 25.

Division of Decimals.

The division of decimals is an operation for which it is difficult to give one simple and comprehensive rule applicable to all cases.

We shall first examine some of those cases, and then give a rule which embraces all of them, and which, with the help of the explanations accompanying these cases, the student will be able to apply to all of them.

Case 1.—Where the number of decimal places in the dividend exceeds the number of decimal places in the divisor.

Example 1.—Divide ·38033 by ·521.

$\cdot38033 \div \cdot521 = \frac{38033}{100000} \div \frac{521}{1000} = \frac{38033}{100000} \times \frac{1000}{521}$

$= \frac{38033}{521} \times \frac{1000}{100000} = \frac{38033}{521} \times \frac{1}{100}$

$= 73 \times \frac{1}{100} = \cdot73.$

Now, this result shows us that the required quotient is to be got by first dividing dividend by divisor just as if they were whole numbers, no notice being taken of the decimal point, and then cutting off a certain number of places of decimals (two in the present example).

The student will see that in this example the necessity for cutting off these two decimals arises from the fraction $\frac{1}{100}$.

Now, is there always such a fraction?

The answer to this question must be found by examining the above steps. If we trace back this fraction $\frac{1}{100}$ to its origin, it will be observed that it arises from the fact that the number of decimal places in the dividend exceeds by two the number in the divisor (there are five places in the dividend and only three in the divisor). If this excess were three, four, or five, etc., instead of two, the fraction corresponding would have for its denominator 1 fol-

lowed by three, four, five, etc., ciphers, instead of 1 followed by two ciphers, and accordingly the number of decimal places to be cut off in the quotient would be three, four, five, etc. Hence we see that the number of places to be cut off in the quotient is the same as the excess of the number of places in the dividend over the number in the divisor.

Rule for division of decimals when the number of decimal places in the dividend exceeds that of the divisor.

Divide as in whole numbers, suppressing the decimal point, and in the quotient cut off as many decimal places as the number of places in the dividend exceeds the number of places in the divisor.

This rule is simple and satisfactory for the case with which it deals—namely, the case where there are more decimal places in the dividend than in the divisor; and it includes

Case 2.—Where the number of places is the same in both dividend and divisor.

NOTE.—This Case, and the Rule in it, may be considered a particular case of Case 1.

Example.—Divide 38·033 by ·521.

$$38{\cdot}033 \div {\cdot}521 = \tfrac{38033}{1000} \times \tfrac{1000}{521} = \tfrac{38033}{521} = 73.$$

So that in this case the simple rule is, Divide as if the numbers were whole numbers.

This rule is, in fact, included in that of the first case, for there being the same number of decimal places in divisor and dividend, the number of places to be cut off from the quotient is 0.

But again suppose

Case 3.—Where the number of decimal places in the divisor *exceeds* that of the dividend.

Example.—Divide 3803·3 by ·521.

$$3803{\cdot}3 \div {\cdot}521 = \tfrac{38033}{10} \times \tfrac{1000}{521} = \tfrac{38033}{521} \times 100 = \tfrac{3803300}{521} = 7300.$$

This shows us we must annex as many ciphers to the dividend as the number of places in the divisor exceeds the number in the dividend, and then divide as in whole numbers.

In the examples we have taken, the quotient comes out exactly without remainder.

But take the example ·315 ÷ 2·7.

```
2·7)·315(·11
    27
    ---
     45
     27
     --
     18
```

Here, following the rule, we get ·11 as quotient. But what is to be done with the remainder, 18? Now, we might have annexed as many ciphers as we wished to the dividend without altering its value; or, what is the same thing, we might *suppose* them to be annexed, and bring them down successively in the division. We may therefore continue the above division thus:—

```
2·7)180(66...
   162
   ---
    180
    162
    ---
     ...
```

Evidently we can go on getting as many figures as we wish in the quotient. The quotient is therefore ·1166...

XXVIII.

THE SUN.

THE sun is the largest, most massive, and altogether the most important member of the solar system, serving as it were as the centre round which all the other members move. It consists of an enormous spherical body whose nature is quite unknown, surrounded by an intensely heated gaseous envelope; and all our knowledge of the constitution of the sun is confined to what we have learned about the nature of this envelope. What is beneath this envelope we do not know, though much speculation as to its probable nature has been indulged in by different astronomers—from Sir William Herschel, who at one time imagined that beneath the dazzling cloud-layer we see there might be another world, fairer and brighter, but analogous to our own, to Professor Young, who imagined that the sun might be a mere bubble and completely hollow in the interior. The intensely brilliant surface of the sun, which is all that we see, is merely the denser strata of its atmosphere rendered opaque by its great brightness: it is not improbable that the greater portion of the unknown interior of the sun may also be gaseous, and perhaps still hotter than the outer layer which we alone can see; but in the present condition of our knowledge all considerations of this nature must be considered merely speculative, without any real evidence to back them.

Condition of the sun.

Until recently it was supposed that we should never gain any knowledge of the materials which constitute the sun; though, reasoning from analogy, it was considered most probable that they would be analogous to those known to be the principal constituents of the earth. Twenty years ago a series of brilliant discoveries completely changed this, by revealing a method of analysing the light coming from any source, and by noting what rays were present and which were absent, learning what bodies had emitted these rays and through what bodies it had passed on its journey to the earth. These brilliant discoveries led to the foundation of a new branch of science, called *Spectrum Analysis*, which is founded partly on Optics and partly on Chemistry.

Spectrum analysis.

It had long been known that when a pencil of white light was passed through a prism it was spread out into a *spectrum*, as it was called, or a band of different coloured light—a band coloured like the rainbow, with red at one end, then orange, yellow, green, blue and violet. Every white-hot body was found to give the same rainbow-coloured band or the same continuous spectrum. Now, the main point in the discoveries which led to the foundation of this new branch of science called

spectrum analysis, was the discovery of the fact that when one of the metallic elements was heated to incandescence in a gaseous state, the light coming from it when passed through a prism no longer gave a continuous rainbow-coloured band, but a number of bright but different coloured lines

Spectra.

the light coming from a yellow star, and instead of a spectrum consisting of a continuous rainbow-coloured band of light he found a spectrum consisting of two bright orange-yellow lines close together, he would know that the light from that star proceeded from incandescent sodium vapour. He would know

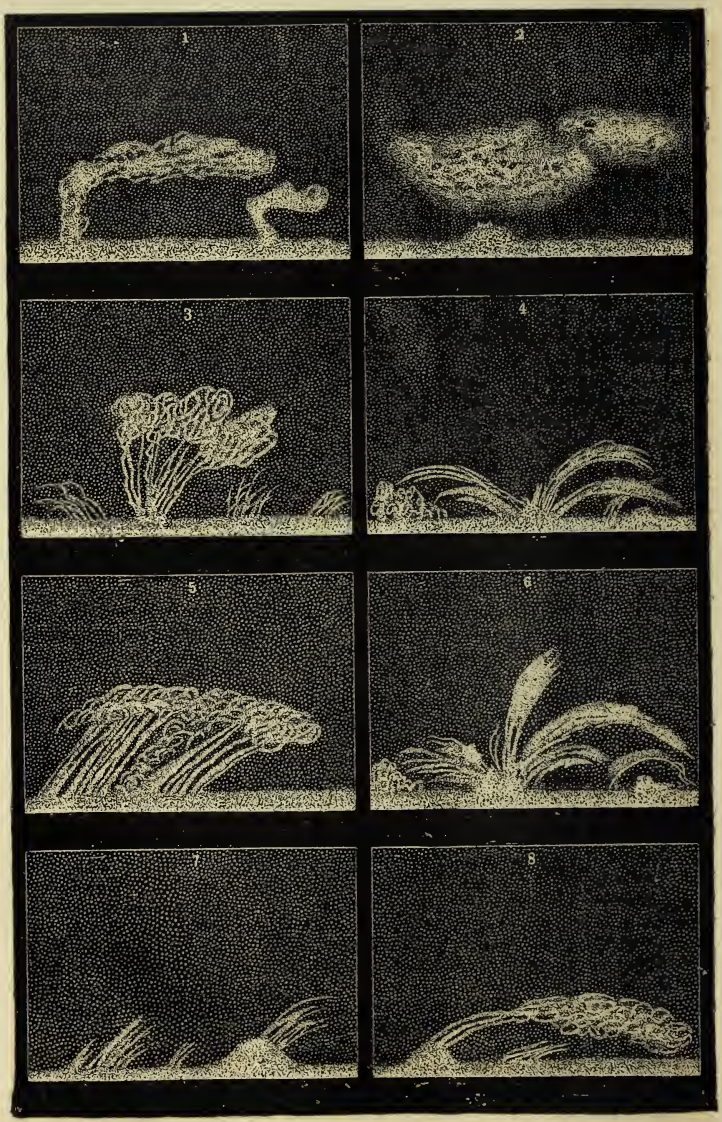


FIG. 74.—SOLAR PROMINENCES.

of light. Thus when the vapour of metallic sodium, one of the chemical elements, was heated to incandescence, its spectrum was found to consist of two bright orange-yellow lines, very close together, instead of the long continuous rainbow-coloured band of light which was yielded by all hot solid bodies. Supposing, therefore, an astronomer proceeded to analyse therefore, without ever having been there, or even having received any portion of the substance of that star, that it was composed of the chemical element sodium.

Further experiments led to still more important results: if it were only the elements which gave these characteristic spectra, and their compounds gave others, the number of

these compounds is so immense that it would be impossible to identify them; but it was found that when any compound containing the element sodium was so heated as to yield an incandescent vapour, the light from this vapour yielded the two orange-yellow lines of sodium

Spectra of compounds.

spectra: thus the metal lithium gave one red and one orange line, potassium two in the red and one in the violet, thallium a vivid line in the green, calcium lines in the yellowish-green and orange. When two or more elements were present, it was found that each gave its own proper spectrum independent of the other;

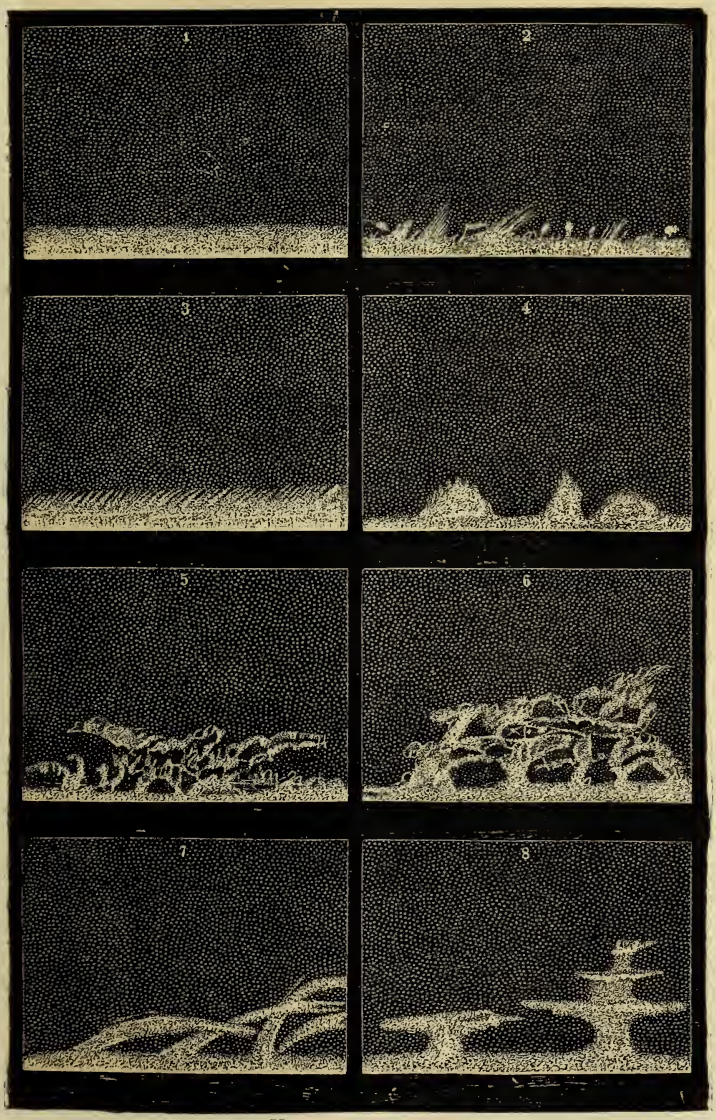


FIG. 75.—SOLAR PROMINENCES.

as distinctly as the vapour of the metal itself. Thus when common salt, which is a compound of sodium and chlorine, is heated sufficiently to yield an incandescent vapour, the light from this vapour gives the two orange-yellow lines characteristic of the presence of the element sodium. It was soon found that the other metallic elements gave similar characteristic

thus the light coming from the vapour yielded by an incandescent mixture of compounds of sodium and potassium would give a spectrum showing not only the two orange-yellow lines characteristic of sodium, but the red and the violet lines characteristic of potassium. It was soon found that it would be necessary to distinguish between different

red or orange lines; but it was easy to do this by measuring their exact position in the spectrum, or say from some one point taken as a standard. Further experiment showed that many of the non-metallic elements gave their characteristic spectra also: thus incandescent hydrogen gave a spectrum of three conspicuous lines—one red, one greenish-blue, and one violet; oxygen gave a long group of lines principally in the blue and violet, and so on.

XXIII.

PRACTICAL APPLICATION—(*continued*).

(2) Conjugation of *Finir*, to finish, continued.

CONDITIONAL.

Present or Future.

je finiRAIS, *I should finish,*
tu finiRAIS *etc.*
il finiRAIT
nous finiRIONS
vous finiRIEZ
ils finiRAIENT

Past.

j'aurais (eusse) fini, *I should have*
tu aurais (eusses) fini [*finished, etc.*
il aurait (eût) fini
nous aurions (eussions) fini
vous auriez (eussiez) fini
ils auraient (eussent) fini

IMPERATIVE.

finIS, *finish (thou)*
qu'il finISSE *let him finish*
finISSONS, *let us finish*
finISSEZ, *finish (ye)*
qu'ils finISSENT, *let them finish*

SUBJUNCTIVE.

Present.

que je finISSE, *that I may*
que tu finISSES [*finish, etc.*
qu'il finISSE
que nous finISSIONS
que vous finISSIEZ
qu'ils finISSENT

Imperfect.

que je finISSE, *that I might finish,*
que tu finISSES *etc.*
qu'il finît
que nous finISSIONS
que vous finISSIEZ
qu'ils finISSENT

Perfect Definite.

que j'aie fini. *that I may have*
que tu aies fini [*finished, etc.*
qu'il ait fini
que nous ayons fini
que vous ayez fini
qu'ils aient fini

Pluperfect.

que j'eusse fini, *that I might have*
que tu eusses fini [*finished, etc.*
qu'il eût fini
que nous eussions fini
que vous eussiez fini
qu'ils eussent fini

Remarks.—1. A verb has never fewer than three circumflexes: these appear on the 1st and 2nd persons plural of the perfect definite indicative, and on the 3rd singular imperfect subjunctive. In the corresponding compound tenses the circumflex appears on the same persons also. In all those cases it indicates a lapsed *s*.

2. The imperfect subjunctive is like the present of the same mood, with the exception of the 3rd person singular.

3. It will be seen that, with the exception of the past participle, perfect definite indicative, and imperfect subjunctive, the terminations of *finir* are identical with those of the 1st conjugation, and that even where they differ they follow similar lines.

(3) List of Verbs conjugated like *Aimer* and *Finir*:—

trouver	*to find*	cacher	*to hide*
franchir	*to cross*	périr	*to perish*
gravir	*to climb*	observer	*to observe*
marcher	*to march*	embrasser	*to embrace*

EXERCISE XXXIV.

1. *Write in full:* 17, 177, 15, 550, 193, 1009, 11,001, 1881. 2. Leap year has 366 days. 3. In our garden there are twenty large trees. 4. Has April thirty or thirty-one days? it has (*il en a*) thirty. 5. The earth rotates once (*tourne une fois sur elle-même*) in (*en*) twenty-three hours fifty-six minutes and four seconds. 6. Truth (*vérité*, f.) is one. 7. Nine hundred and ninety-nine is written with (*s'écrit par*) three nines. 8. This book has three hundred pages (f.) 9. You will find it (*le*, before the verb) at (the) page eighty. 10. I would cross the gutter twice or thrice (*ruisseau*, m. 2 *fois*, 3 *fois*). 11. Let them climb the hill (*colline*, f.) two by (*par*) two, or three by three. 12. Let them march four abreast (*quatre à quatre*) or five abreast. 13. A *five-franc piece* (*pièce de cinq francs*, f.) with (*à*) the date (*millésime*, m.) of 1840. 14. I should have finished the *Arabian Nights* (one thousand and one nights) if you had not hiddcn the book. 15. The one thousand and one days is the name of a collection (*nom*, m., *recueil*, m.) of Persian tales (*contes persans*). 16. They were believing (*croyaient*) that the world (*monde*, m.) would perish in (*en*) the year one thousand. 17. They observed (*take perfect indefinite*) the transit of Venus (*passage*, m., *Vénus*) in 1874; I *wish they would* (would wish that they might) observe it (*l'*) again (*de nouveau*) in 1882. 18. How far is it from London to Edinburgh by rail? it is about 400 miles (*combien y a-t-il de Londres à Edimbourg par le chemin de fer? il y a environ . . .*). 19. Charlemagne was crowned (*couronné*) emperor at Rome, in the year 800. 20. The middle ages (*moyen âge*, m. sing.) embrace the period comprised between (*la période comprise entre*) the fall (*chute*, f.) of the [2]Roman [1]empire, (m.) in 475, and the fall of Constantinople, in 1453.

NUMERAL ADJECTIVES (*continued*).—THEORY.

1. THE ORDINAL NUMBERS.—These are formed by adding *ième* to the cardinal numbers, the final vowel of the cardinal, where there is one, being suppressed. They agree in gender and number with the noun they qualify.

M.S.	F.S.	M.P.	F.P.
1st, premier,	première,	premiers,	premières.
2nd, second,	seconde,	seconds,	secondes.
deuxième,		deuxièmes.	

3rd, troisième
21st, vingt-et-unième (*vin-té-unième*)
4th, quatrième
22nd, vingt-deuxième (*x* = *z*)
5th, cinquième
30th, trentième
6th, sixième (*x* = *z*)
40th, quarantième
7th, septième (*p* mute)
50th, cinquantième
8th, huitième
60th, soixantième (*x* = *ss*)
9th, neuvième
70th, soixante et dixième
10th, dixième (*x* = *z*)
71st, soixante et onzième
11th, onzième
80th, quatre-vingtième
12th, douzième
81st, quatre-vingt-unième
13th, treizième
90th, quatre-vingt-dixième
14th, quatorzième
91st, quatre-vingt-onzième
15th, quinzième (*kin*)
100th, centième
16th, seizième
101st, cent-unième
17th, dix-septième
200th, deux centième
18th, dix-huitième
1000th, millième
19th, dix-neuvième
100000th, cent millième
20th, vingtième
1000000th, millionième

It will be seen that with the exception of 1st, 2nd, and 9th, the ordinals are all formed regularly.

a. The cardinal are used for the corresponding ordinal numbers with names of sovereigns and in dates: *Henri quatre abjura le vingt-cinq juillet* 1559, Henri IV. made his abjuration on the 25th of July, 1559.

Premier is excepted: *François premier*, Francis I.; *le premier janvier*, the 1st January. One may say *Henri deux*, or *second*; *François deux*, or *second*. *Quint* is used as a numeral only in speaking of the Emperor Charles V. and of Pope Sixtus V.: *Sixte-Quint, pape* (A.); *Charles-Quint prodiguait déjà en Europe les trésors du Mexique* (Volt.)

b. In referring to books, etc., the use of the cardinal for the ordinal numbers is optional; but there is a certain difference between *second* and *deuxième*: *le second tome* means the second volume simply of a book which may either have two, or more than two volumes; but if the expression *le deuxième tome* be used, it presupposes at least a third.

c. Adjectives of dimension are placed immediately after the noun, and are followed by *de*: *un bâton long de tant de pieds* (A.), a stick so many feet long; *un mur haut de sept pieds* (A.), a wall seven feet high.

Remark.—Here are four more constructions to express the dimensions of any object: *une cour de vingt mètres de long*, or *de longueur*; *cette cour a vingt mètres de long*, or *de longueur*; *la cour est longue de vingt mètres, la cour a une longueur de vingt mètres.*

d. The adjective which comes after a numeral is preceded by *de*: *il y eut mille hommes de tués; il y en eut cinq mille de blessés*, there were a thousand men killed; there were five thousand wounded.

2. Here are added certain classes of words used to denote peculiar relations of numbers—the collective, proportional, and fractional.

a. COLLECTIVE.—These are: *une dizaine*, a collection of 10, or about 10; *une douzaine*, a dozen, or about 12; *une quinzaine*, 15; *une vingtaine*, 20; *une trentaine*, 30; *une quarantaine*, 40; *une cinquantaine*, 50; *une soixantaine*, 60; *une centaine*, 100; *un millier*, 1000. These all can take the sign of the plural. Examples: *Je dépenserai une cinquantaine de francs*, I shall spend about fifty francs; *Combien en voulez-vous? donnez-m'en une quinzaine*, how many do you want? give me about fifteen; *Des milliers de gens l'ont vu*, thousands have seen it. — *Trentaine, quarantaine, cinquantaine, soixantaine, centaine*, are used absolutely to denote age: *Elle a passé la trentaine*, she is over thirty; *Il frise la cinquantaine*, he is close upon fifty.

Remark I.—The word *huitaine* denotes generally a se'nnight; *quinzaine*, a fortnight; *neuvaine*, a special course of prayers, extending over nine days; *quarantaine*, quarantine, whether of forty days or less: *on nous imposa une quarantaine de trois jours*, we were submitted to a three days' quarantine.

Remark II.—These adjs. denote a person of a certain age: *quadragénaire* (r. *coua*), of 40; *quinquagénaire* (r. *cuin-coua*), of 50; *sexagénaire*, of 60; *septuagénaire*, of 70; *octogénaire*, of 80; *nonagénaire*, of 90: *centenaire*, of 100.

b. PROPORTIONAL.—These are: *double*, twofold; *triple*, threefold; *quadruple* (r. *coua*), fourfold; *quintuple* (r. *cuin*), fivefold; *décuple*, tenfold; *centuple*, hundredfold. No others are in use.

c. FRACTIONAL.—Fractional parts are expressed by ordinal numbers preceded by the article: *le sixième*, one-sixth. Except:

a half, *la moitié*, or *la demie*; also *le demi*,
a third, *le tiers*, a fourth, *le quart*.

La moitié and *la demie* express the half of any object; *le demi* is the fraction $\frac{1}{2}$ in arithmetic. The following instances show how fractions ought to be read in French: $\frac{3}{5}$ths, *trois neuvièmes*; $\frac{13}{15}$ths, *treize quinzièmes*; $\frac{1}{1111}$th, *un mille cent-onzième*; ·3, *trois dixièmes*; ·0003, *trois dix-millièmes.*

III.

FRICTIONAL ELECTRICITY (*continued*).

IN the way mentioned in the close of our last article (p. 42) you can charge an electroscope with excited sealing-wax: *negatively* if by *conduction*; *positively* if by *induction*. The results we there mentioned you should obtain from your electroscope if properly constructed; and if the insulation (by which the escape of the electricity is prevented) be perfect, the electroscope will retain a charge for some hours.

The gold-leaf electroscope, when carefully constructed, forms a most useful and instructive instrument in the hands of the student, as by its aid he may prove for himself the accuracy of a very large number of the statements which in these papers it will be our duty to make. We have already made one or two such statements; and it will be good practice, and also a good test of the trustworthiness of our electroscope, to at once set about proving them, as may be easily done by the following interesting and simple experiments.

Experiments with the electroscope.

First charge your electroscope, in the manner described above, with positive electricity—that is to say, hold near, but not touching it, a stick of sealing-wax which has been excited in the usual way by friction with flannel—and then, previously to removing the wax, touch the disc of the electroscope with the finger; the gold leaves will then diverge with positive electricity. Now bring the flannel rubber near the electroscope, and it will be seen that the leaves will diverge still more, showing conclusively that the rubber is charged with the same kind of electricity as are the gold leaves.

Now, we have agreed to call that kind of electricity which is developed upon wax when rubbed with flannel *negative* electricity; therefore the electricity of the flannel must be *positive*. Hence we have proved the truth of the statement that when electricity is produced by friction, both the rubber and the body rubbed become electrified, the electricity developed on one being of the opposite kind to that developed upon the other; it can also be proved that the *quantities* of electricity thus produced are always equal, but more complicated apparatus is required for the purpose than it ordinarily falls to the lot of the average student to possess. It may, however, be approximately determined by exciting a small stick of sealing-wax with flannel, and then laying both together on the disc of the electroscope. It will be found that so long as both rubber and wax remain the leaves will not diverge, but if either be removed they will at once become charged with electricity—*positive* if the wax be removed, *negative* if the rubber. This experiment undoubtedly tends to show not only that both rubber and body rubbed are oppositely electrified, but also that the quantities of each kind of electricity are the same, because when they are both allowed to exert their influence upon the electroscope at the same time, they balance and therefore neutralize each other.

The above experiments may be varied in an almost endless variety of ways, but always with the same result. When testing only small quantities of electricity, it will be found best to first charge the electroscope with the electrified body under examination, and then to test the electricity of the gold leaves by bringing near an electrified glass rod or stick of sealing-wax. When larger quantities of electricity are being examined, first give a feeble charge to your electroscope of either positive or negative electricity, and then bring near the body whose charge of electricity is to be tested. In all cases remember that *repulsion* is the only reliable test; a neutral body will cause the leaves to collapse by discharging them; an electrified body alone can cause them to diverge.

Another interesting series of experiments with the electroscope is the following:—Provide yourself with two or three yards of fine copper wire, and the same length of ordinary dry silk string. First attach one end of the wire to the metal rod of the electroscope, and wind the other once or twice round the rod. Then, standing as far from the electroscope as the wire will allow you, rub the glass rod with the silk rubber; immediately the leaves will be seen to diverge. Next substitute for the wire the silk string, and proceeding as before, it will be found that no amount of rubbing will cause the leaves to diverge. Finally, *wet* the string, and now it will be seen that the electroscope is as readily charged as when the wire was employed, or as when the rod itself was brought into actual contact with the electroscope.

Experiments to illustrate conduction.

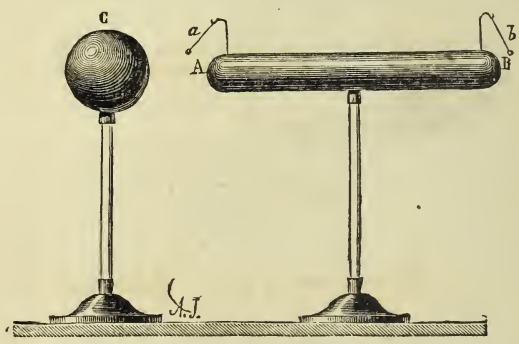


FIG. 8.—INDUCTION ILLUSTRATED.

What do these experiments mean? Obviously, that copper is an excellent conductor, silk a bad conductor, and water a very good conductor of electricity. In the same way, by testing various substances, we may arrange them in order, according to the difficulty or ease with which they allow electricity to pass along them.

Meaning of the experiments.

Electrical Induction.—We have hitherto been mainly studying the simple facts of the attraction and repulsion of electrified bodies, and of the communication of electricity from one body to another by actual contact, or, as it is termed, by *conduction*. We have now to study the manner in which neutral bodies may be influenced by electrified substances at a distance, which method of communicating electricity is known as *induction*.

One example of this method we have already had, in the second mode of charging our electroscope, it having been necessary to so far anticipate the present section. A very easy method of

Experimental illustrations.

illustrating induction is given in our diagram (fig. 8). AB is a brass cylinder with rounded ends, supported upon an insulating stand consisting of a glass rod covered with shell-lac varnish. At each extremity is a small wire fixed into the cylinder by one end, and having suspended from the other a small pith ball (*a b*). Near to this insulated conductor is brought an electrified metal ball, C, similarly insulated to the conducting cylinder. We will suppose that the metal ball C is charged with *positive* electricity; it will then be seen that the pith balls, which were at first vertical, are drawn from that position, but in opposite directions—*a* being drawn towards C, *b* being repelled from it. It can easily be shown, by means of the proof-plane and the electroscope, that the end A of the cylinder AB is endowed with negative electricity, and that the end B is endowed with positive electricity. It may also further be shown that the ends of the cylinder are more powerfully electrified than the other portions, and that midway between the two ends there is a so-called "neutral line," which exhibits neither positive nor negative electricity. Now let C be removed, and the pith balls will instantly collapse.

Instead of merely one cylinder, several might have been employed, and the pith ball of each would have diverged as in the case just supposed; but the divergence of the pith balls of the first cylinder would have been greater than that of those upon the second, and so on—the amount of electrical disturbance getting gradually less as the distance from the electrified body increased. Moreover, when only a single cylinder is employed, it will be seen (as represented in the figure) that the divergence of the one nearest to the electrified ball is greater than that of the one at the opposite end.

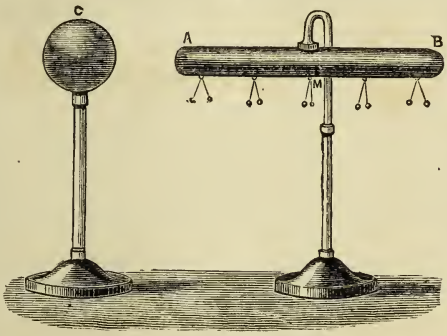


FIG. 9.—INDUCTION ILLUSTRATED.

Instead of employing brass as the material for our ball and cylinder, the same results may be obtained with cheaper and more easily manipulated materials. A wooden ball covered with gilt paper or tin-foil will do quite as well as a metal one; and a wooden cylinder, or even a hollow cardboard one, similarly covered, will supply the place of a brass cylinder. In order to cover the ball with the gilt paper or tin-foil, the latter must be cut into narrow strips and carefully pasted or glued on. If a hollow cardboard cylinder be used, two wooden balls covered with metal paper and made to fit into the ends of the cylinder will answer very well for its rounded extremities. If the glass stands are not available, both electrified ball and conducting cylinder may be suspended by silk threads, in which case it will be best to dip the threads in melted paraffin wax.

A less costly form of the above apparatus.

A variation of the last experiment is shown in our next diagram (fig. 9). As before, AB is an insulated conducting cylinder, and C an electrified metal ball similarly insulated. Suspended from the under side of AB are five pairs of pith balls, one pair at each end of the cylinder, one pair in the middle of the cylinder, and the other two pairs one on each side of the middle pair, When the electrified body C is brought near AB, all the pith balls diverge, with the exception of the central pair; but, as is shown in the diagram, the balls at the two ends of the cylinder are more powerfully acted upon than those between the ends and the central pair, while the latter remain entirely unaffected. If the electrified body be now removed, all the balls will, as in the first experiment, immediately collapse.

Variation of foregoing experiment.

Again, let us pause to ask ourselves the meaning of these two experiments; and before going farther, let us attempt to realise, if we cannot altogether explain, the condition of the pith balls during the experiment.

Theoretical explanations.

Now, it must be evident that the electricity of C is not conducted through the air to AB, because if it were the whole of AB and therefore all the pith balls would be similarly electrified, and their electricity would moreover be of the same kind as that of the electrified conductor C. That the latter is not the case may be easily proved by bringing an electrified glass rod near them, when those near one end of the cylinder will collapse, while those near the other end will still farther diverge. What really happens, so far as our theory of electricity enables us to explain it, seems to be this: the electrified body, when brought near to the unelectrified conductor, decomposes its electricity, attracting towards that end of the cylinder which is near itself the electricity which is of the opposite kind to that with which the ball is endowed, while the electricity which is of the same kind as that upon the ball is driven to the opposite end of the cylinder; this taking place by virtue of the law which we verified at the commencement of our studies,—viz., that like electricities repel, unlike electricities attract each other. This action of an electrified body upon a neutral body without actual contact is known as INDUCTION. If, before removing the (we will suppose) positively electrified body, the cylinder AB be touched for an instant with the finger, and then the ball C be removed, the cylinder will be found to possess only negative electricity, and in this case the positive electricity of AB, being repelled by that of C, escapes through the body to the earth, when it is enabled to do so by the hand being brought into contact with it;

and the ball C being then removed, the negative electricity is set free and diffuses itself over the whole of AB, which thus remains negatively electrified.

BY ROBERT SOMERS.

I.

METHOD OF INQUIRY—DIVISION OF LABOUR AND EXCHANGE—SUPPLY AND DEMAND.

WRITERS on political economy usually treat this subject under the general heads of "the production and the distribution of commodities"; and if to these be added their counterparts, viz., the consumption and reproduction of commodities, it may be said that the compass of the subject is fully embraced. They are gates at least through which this important department of knowledge and reason may be conveniently entered. For production and distribution immediately bring up labour, property in the produce of labour, land, capital, machines and stock as the agents of production, with rent, wages, and profits as the main distributive channels of all the commodities produced. The term "services" may as well be used here as "commodities," for there are many cases in which no commodity in the sense of a material product is given—as that of a physician or a lawyer who gives his advice; and even under the form of commodity, whether it be a yard of calico or a bushel of wheat, a service is rendered. An exchange of "commodities" or of "services" is what goes on under all the economic relations.

Divisions of the subject.

METHOD OF INQUIRY.

The object being to discover from observation and experience the principles and policy under which the most prosperous production and the most full and equitable distribution of wealth are promoted among all orders of a community, and among all nations, the method of political economy is fundamentally inductive. Yet one must not enter too freely into an outcry of late years against the too deductive method pursued by eminent political economists; for the reason, in the first place, that there is no inductive method without deduction as its handmaid; and, in the second place, for reasons peculiar to such a science as political economy. The most scientific method cannot advance without its hypotheses, which are only deductions, largely conjectural, from previously ascertained results. Political economy is not one of the "fixed sciences." Physical science, and nearly all what are called "laws of nature," indeed, are included in its problems, and in a manner centre in it. Professor Jevons even holds that it is a mathematical science; and the intimacy with which quantity and number enter into its largest conclusions may render this more than a merely fanciful idea.* Mr. Mill, who, as a master of logic probably felt keenly the complex character of economic science, declared it to be an instance of the "concrete deductive method" described in his work on logic.† The truth is that political economy contains an element not found in the study of physical or even physiological science. It has to deal with the human mind and the human will, and with the motives by which mankind in general are seen to be actuated in given circumstances. It is more to be compared to a socio-historical science, or a philosophy of history, than to astronomy or to a philosophy of the planetary heavens. And, finally, it is a moral science. The terms of political economy must be understood in a strictly moral sense. They assume, in short, a moral action throughout. The "competition," for example, occurring in economical treatises, must not be confounded with the competition often seen in the action of men and companies of men, who yet would probably be surprised to think that they are not economists in what they feel and what they do.

Fundamentally inductive.

A moral science.

DIVISION OF LABOUR AND EXCHANGE.

Adam Smith laid the proper basis of economic doctrine in the first chapter of his famous work,‡ where he describes "the division of labour." When men began to produce one commodity, and to do one piece of work or part of a piece of work rather than another, or none, then began the whole economic evolution as we have it now. Exchange, comparative valuation of one commodity with another, markets the action of supply and demand on specific industries, increase of competition in the industries most prosperous, decline of competition in those losing their customary valuation; and as labour became still more minutely divided, and markets more numerous and extended, the invention of money—a common instrument of more steady or legally determined value than other commodities—whereby the huge inconvenience of direct barter of two commodities, one for the other, were to be removed, and each commodity in any quantity could be sold separately for a "price" in money, accepted not only for what it was worth in itself, but still more for the commodities it would at once buy in any portions at the "prices" current in the markets;—all these developments, etc., arose in necessary course out of the application of human beings to particular branches of production. Give the one, and the others were sure to follow.

Division of labour.

This "division of labour" must have been one of the earliest instincts of men, when thinking of a peaceful, industrial, and civilised life. It implied steady application to useful work or business, and with this impression also a dependence on the general community—a trustful expectation or assurance that the work of one man would exchange in fair value for

* "Theory of Political Economy."
† "System of Logic," Book VI., chap. ix., s. 1.
‡ "Wealth of Nations," Book I., chap. i.

the works of other men. It gave, moreover, individual freedom of choice in work—a self-evolving organisation of society where not corrupted by slavery or trodden down by an overruling despotism—always welcome to the heart of the human race, and in rude and barbarous times affording a pleasant escape out of eternal vicissitude and privation. Each would choose the industry for which he had most aptitude, and being apt, would not only have more pleasure in his work, but the aptitude increasing by exercise, the labour expended would be found in practice to become much more productive. Hence the greater riches of the whole community, and the charm of a constant multiplication of commodities which no disorganised or compelled labour could have brought forth.

Let not the reader misapprehend the term "division of labour." Under this process labour is divided only to be more thoroughly united, one part fitly joined to another, and all parts forming one grand system. It is in reality the most radical, complete, and penetrating of all co-operations of labour. The co-operative societies superimposed on this natural stock may be good enough, but they are superficial and feeble in comparison, whether in consolidating the interests or extending the sphere of labour.

A caution.

Under Adam Smith's teaching the view of political economy has much changed as to the origin and nature of wealth.* "Labour is the source of all wealth" is now the common doctrine, giving to labour, of course, its full signification, and differing widely from the tenet of the early French "economists," who held that land is the source of wealth—a specious view, likely enough to impose on the judgment under the first impression that wealth or commodity always presents itself in the form of material substance, but which, on being closely examined, is found to be without foundation, either in the experience or reason of the case. For land itself is worthless until human labour has been applied to it in strong and continuous force. The timber felled and hauled from primeval forests does not obtain value in exchange for its substance —even though the utility may reside in its substance and in nothing else—but, on the contrary, for the labour outlays, the risks, and charges of bringing it to market. It is not to be denied, indeed, that any one who has acquired at small cost a tract of desert land full of valuable vegetable growths has got a very good thing in hand, any more than it is to be denied that any one who chances to light upon a gold-field may very easily fill his pockets from it. These windfalls belong to the spirit of industrial and commercial adventure, very generally useful of itself in human affairs as a pioneer of much future regular industry, but seldom rising above the rank of pioneering either in distinction or in wealth. On the principle

Changed views.

* The keynote was struck by Dr. Smith in the first sentence of the introductory chapter of his work—the well-known words beginning, "The annual labour of every nation is the fund which originally supplies it with all the necessaries and conveniences of life," etc.

that one industry is as free as another, and as free to many as to few, the uniform and rapid tendency of all new-found sources of wealth, even on the most El Dorado scale, is to descend in the exchange-value to a fair average return of wages, profit, risks, and charges—such being the condition on which labour and capital are willing in abundance to work. So also of the productive forces derived from science and mechanical inventions. The expansibility of steam, for instance, in all the immense productive force it is putting forth, costs us nothing in the purchase of its innumerable products beyond the mechanism, fuel, and attendance necessary to the steam-engine and boiler. Political economy thus contains, and has fairly within scope of its most solidly-established principles, a practical communism of all the contributions of Nature to human industry.

The motive of "division of labour" being to call forth the productive faculty of the individual man in the form most fit and accessible to himself, it proceeds on the understanding (1) that what one man produces he will be able to exchange for what other men produce, or, in other words, by the one product of his labour be able to command a variety of other products necessary to his wants; and (2) that this exchange will be an exchange of equity, or according to the quantity and quality of the work expended on the several products. The goods and produce have thus to be brought to exchange or sale, to deliberate comparison and test of their several values; and this is what constitutes "a market," the cardinal condition of which is that the market shall be free and open, and conducted throughout with intelligence and integrity. It is obvious that any forcible restriction of a public market, whether in one commodity or in several, any artificial bounty in favour of one commodity or prohibitive duty against another, directly corrupts the equity of exchange, and is, in fact, a fraud upon the general producers and the general consumers. The care and many laws, as we read, of our forefathers, long before political economy had become a study in the United Kingdom, to keep free, open, and equal markets, show that they had a perception from experience of a great fact which required only time—though a very long time—to arrive at: the much larger generalisation, now accepted in this country at least, that freedom of market is as necessary to the equity of exchange in the international as the domestic sphere of commerce. A fuller outline of this deeply interesting domain of political economy will arise under the head of "Value," in which the principal elements of the science may be said to centre. But, before passing on, a few sentences may be added on

Exchange.

SUPPLY AND DEMAND.

When the supply of a commodity is greater than the demand, the commodity tends to fall in "price," which, as the common intermediary term of money, is only another way of saying that it falls in exchange-value with some other commodities; and when the demand is greater than the supply it tends to rise in "price," in

the same sense. This proceeds on the plain law that when there is more than enough of a commodity the surplus declines rapidly in utility, and so affects the exchange-value of the whole; less than enough having the contrary effect of increasing the utility of every part of the supply, and consequently increasing its exchange-value. It has further to be observed that while the variations of supply and demand have this action on the value of a particular or of any commodity, there is no fundamental discordance between supply and demand, as regards the total production. All supply of products is a demand for other products, and all demand for products is, in the necessary condition of purchase, a supply of other products. The two forces, therefore, can never be unequal to each other. They are the same force under two aspects, and only vary when the supply of a commodity is greater or less than the demand for that particular commodity —that is to say, they vary in the details of exchange without effect on the aggregate value of commodities. This will be found well expounded by the late Professor Cairnes.* When a commodity rises or falls, under the action of supply and demand bearing directly upon it, the signification is—and this point the student must see clearly at the outset—that some one or other commodities have fallen or risen in equal proportion.

GENERAL WALLENSTEIN.

XXIX.

THE THIRTY YEARS' WAR (*continued*).

THE triumph of Ferdinand and the rapidly increasing ascendency of the Austrian house was watched with equal interest and jealousy by foreign nations. The Protestants feared the utter extinction of their religion, the Catholics dreaded the overthrow of the balance of power in Europe; and both were accordingly inclined to unite in weakening the German empire. Cardinal Richelieu, whose profound statesmanship at that time guided the policy of France, saw in Ferdinand a dangerous rival to his master, Louis XIII. James of England assisted Count Mansfeld with money and troops. Christian of Brunswick was enabled once more to take the field. A far more formidable foe presently arose against the Austrian house. The ambitious Christian IV. of Denmark, anxious to extend his territories by conquests in Northern Germany, and seconded by France, Holland, and England, appeared in the field against Ferdinand. The emperor, till now dependent for his armies on Tilly and the League, resolved to set on foot a separate army. For this purpose he applied to that great Bohemian noble, "the adventurous son of fortune," who became the great central figure of the contest, Albert Waldstein or Wallenstein, of Königingrätz. This remarkable man had proved himself, in many battles, a stout soldier and a skilful chief. He possessed enormous wealth, partly acquired through marriage, and partly by the purchase of confiscated estates; and had been rewarded by Ferdinand for his services in the Bohemian war, first with the title of Duke of Friedland, and afterwards with rank among the princes of the empire. Magnificent in rewarding, and inexorable in punishing, he attached his soldiers to himself alike by gratitude, admiration, and fear; and his belief in astrology added an element of mystery to his life which increased his influence with those around him, and high and low were eager to attach themselves to his fortunes. Wallenstein responded to the emperor's proposal that he should collect twelve thousand troops, by offering to raise a far larger number. "Twelve thousand I cannot maintain," he is reported to have said; "but I will bring together sixty thousand, and I warrant they won't die of hunger." He meant that sixty thousand men would take what they needed, in the country of friend or foe; and that war should be made to pay for itself. Ferdinand was not, on the whole, ill-pleased to see a great army fighting his battles and costing him nothing. Fortune in the Danish war was with Wallenstein

Jealousy aroused against Austria.

Albert Wallenstein, Duke of Friedland.

* "Some Leading Principles of Political Economy," Part I., chap. ii., ss. 2, 3, 4.

and Tilly. Christian of Denmark effected little on the Weser. Mansfeld, beaten at the Dessau bridge, was pursued by Wallenstein through the whole of Germany to Hungary, where he hoped to be joined by Bethlen Gabor, of Siebenbrügen. But this hope was not realised, and the bold partisan warrior died at Zara, in Dalmatia. It is said that he awaited death in armour, with his sword girded on, and leaning on two troopers for support. Christian of Brunswick, the "mad bishop," had died a few months before. Austria was thus freed from two formidable enemies; and

Defeat of Christian IV. of Denmark.

Christian of Denmark himself was compelled, after Wallenstein had gained the battle of Cozen, to acknowledge himself beaten. Wallenstein purposed to found a new German maritime state on the shores of the Baltic; and in this he might have succeeded but for the heroic resistance of Stralsund, whose citizens shut their gates, and successfully stood a siege in which Wallenstein lost 12,000 men, after swearing in vain that he would have the town "if it were fastened to heaven with chains."

This defeat somewhat weakened the influence of Wallenstein, who had, moreover, drawn upon himself the hatred of the princes and the curses of millions by the ruthless system of plunder by which his motley army was maintained. Still he was a tower of strength to the emperor, whose foes everywhere capitulated; and Christian of Denmark was glad, in the treaty of Lübeck, to compound for his own safety by abandoning the Protestants of Germany to their fate. A very slight amount of moderation and wisdom on Ferdinand's part would have brought the war to a close.

GUSTAVUS ADOLPHUS.

But again the emperor miscalculated his power, and would be content with nothing less than the political annihilation of his opponents. On the 6th of March, 1629, he promulgated the Edict of Restitution, commanding the restoration of all church property alienated from the Catholics since the pacification of Passau, excluding the Calvinists from religious toleration, and putting potent means into the hands of the Romanists for the extirpation of Protestantism. He could not have committed a greater blunder. As the Edict of Restitution affected the interests of all the Protestant princes, it was the measure best calculated to unite them all once more in common resistance against its author.

Edict of Restitution, March 6, 1629.

At this time, too, Ferdinand was obliged, very reluctantly, to sacrifice the man to whom he owed so much. At the diet at Ratisbon, in 1630, a general clamour of the princes, headed by Maximilian of Bavaria, was raised for the dismissal of Wallenstein, whose lawless troops swarmed like locusts through the country, eating up every green thing, and leaving the land a desert wherever their tents had been pitched; and whose haughty leader disregarded all orders of the Government and trampled on princes and people alike. Overcome by the general importunity, Ferdinand disbanded eighteen thousand of his cavalry, and dismissed Wallenstein from the command of his army. "The stars indicate," said the haughty general, "that the spirit of the Bavarian will dominate the spirit of the emperor." Somewhat against the general expectation, he quietly accepted his dismissal, and retired to his Bohemian palace, where he lived in regal state and magnificence, surrounded by a retinue of guards and adherents that eclipsed the court of the emperor himself. He was careful, by princely donations and largesses, to keep around him the officers whom he could trust; for he believed in his fortunate star, and considered the time to be near when the emperor would be obliged to buy his services at any price.

Dismissal of Wallenstein, 1630.

Ferdinand's tyranny had united the Protestant princes of Germany in a renewed effort for freedom; and at this crisis a champion appeared than whom a nobler had never taken upon himself the vindication of a great cause. Gustavus Adolphus, king of Sweden, the grandson of the heroic Gustavus Vasa, had received secret invitations from Germany to raise the Protestant standard once more. The astute Richelieu had promised him help; and the house of Austria had excited his apprehensions by menaces and insults. At a diet held by the king immediately before his departure for Germany, he explained the causes of his interference in the great contest. He presented to the diet his little daughter Christina, then only four years of age, but destined to leave a name in history very different from that of her heroic father. He caused the assembled deputies to take the oath of allegiance to this child; for he felt and expressed a presentiment that he should die in defence of his country and of the Protestant faith; and they, like the friends of St. Paul, mourned at his departure, and most of all for the thought that "they should see his face no more." "It is no light or trivial cause," said the king, "that has moved me to take part in this new and dangerous war. God is my witness that I have not sought the contest. But the emperor has supported my enemies, persecuted my friends and brethren, trampled my religion in the dust; and now he stretches forth his hand to grasp my crown. The oppressed states of Germany call loudly upon us for aid; and,

Gustavus Adolphus lands in Germany, June 24, 1630.

by God's help, it shall be afforded them." The king had also a thorough knowledge of the means by which success could be attained. His system consisted in opposing discipline to licence, the spirit of order and justice to the unreasoning oppression that plundered friends and foes alike. "I know as well as any one," said Gustavus, "the difficulty, the perils, the fatigues, and the duration of such an undertaking; yet neither the wealth of the house of Austria dismays me, nor her veteran forces. The imperial army subsists by rapine and military exactions; whereas, on the other hand, though the Swedish revenues are not great, they are punctually paid; and my soldiers are accustomed to temperance, frugality, and justice. In the worst case, my retreat is secure, and my brave troops shall not want their daily pay, though it comes to them from Sweden; and if it is the divine will that Gustavus shall die in the defence of his country, he will pay the debt with cheerful readiness, for it is the duty and religion of a sovereign to obey, without murmuring, the behests of the great King of kings."

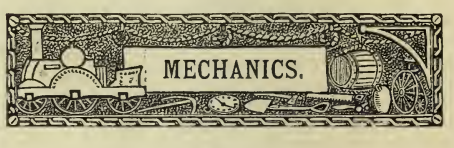
Merits of Gustavus Adolphus.

When Gustavus Adolphus landed, with a well-disciplined force of 15,000 men, on the island of Rügen, on the Pomeranian coast, the princes for whose behoof he came looked upon his undertaking with doubt and incredulity. In Vienna there was contemptuous jesting at the audacity of the "snow king," whose forces would melt away as he marched southward. The old Duke Bogislaw of Pomerania made a treaty of alliance with him; but the Protestant princes held aloof, partly from fear of the emperor's vengeance, and partly from distrust of the "snow king's" ability to effect anything of importance with his small force. But soon it appeared that the Swedes were welcomed as friends and deliverers by the population of Mecklenburg and Pomerania. They paid for all they required, respected private property, and maintained an irreproachable discipline. The imperial garrisons fled before them, and Gustavus' power was firmly established in the provinces of the Baltic. The dukes of Brandenburg and Saxony, however, were slow to ally themselves with the Swedish king. The latter prince especially, who wished to set up Saxony as a separate power, formidable alike to the emperor and to Sweden, induced the Evangelicals, at the Assembly of Leipsic, to decide on a neutral position, abstaining from alliance with the Swedes, but demanding the abolition of the Edict of Restitution, and other important concessions, from the emperor.

Reluctance of the Protestant princes.

An event, remarkable for its deep horror even in those days of rapine and cruelty, once more roused the flagging zeal of the Protestants, and kindled the smouldering discontent into a flame. Magdeburg, bolder than the electorates, had formed a league with Gustavus Adolphus; and against this city the veteran Tilly, now commander-in-chief of the troops of Ferdinand and of the League, led his army. The siege of Magdeburg reads like the story of the victory of Mongol hordes or of Turkish janissaries, rather than the conflict of a Christian army against fellow-Christians and fellow-countrymen. The city was taken by assault; and for four days it was given up to the worst excesses of murder, rapine, and pillage. The soldiers slaughtered the inhabitants in the streets and in the houses without distinction of age or sex. The Walloon troopers of Pappenheim, generally the steadiest and most disciplined troops, distinguished themselves by their cruelty on this occasion; and the brutal Croats, whose name was already a terror in western Europe, added torture and mutilation to the ordinary penalty of death inflicted on the vanquished. Thirty thousand of the inhabitants of Magdeburg were slaughtered in cold blood. Amid a horrible scene of plunder and carnage the devoted city was set on fire in various places; and when, on the fourth day after the assault, Tilly made his triumphal entry, amid the smoking ruins of Magdeburg, the old cathedral and a few poor houses on the banks of the Elbe were all that remained of the once flourishing imperial city. From the cathedral some seven or eight hundred famished captives crept forth to receive quarter at the hands of the victor, and these were almost the sole survivors. Only very few of the garrison, who fought heroically, and three of the officers, one of whom was desperately wounded, obtained conditions. The rest were indiscriminately put to the sword.

Siege and capture of Magdeburg by Tilly, May 1631.



II.

MOTION (*continued*).

§ 7. This seems a convenient opportunity for drawing attention to a very important remark —viz., that the idea of motion (or rest) always implies at least two bodies. In some cases this is clearly expressed in common talk. When we speak of a man sitting still in a railway carriage, for instance, we mean that he does not pass from one part to another of the carriage, nor does he turn round towards another portion of the carriage. Or, if he did change his place, then we should speak of his moving about in the carriage. In this case, then, the two bodies concerned in the motion are expressly named. But in most instances only one body is mentioned, and the other is "understood," but not expressed. When, for example, we speak of a train moving, it appears at first sight that only one thing is concerned; but a little reflection will show you that we mean that the train has moved from one part of the earth's surface to another; so that even here two bodies are concerned—the train and

Two bodies implied.

the earth. So also when we speak of a ship in a rough sea moving up and down, the two things implied are the ship and the earth; because the phrase "up and down" means "further from and nearer to the earth." Another important case is offered in the oft-repeated statement that the earth turns on its axis. There is here a certain ambiguity. When we speak of the rotation of the earth as giving rise to day and night, the two bodies concerned are the earth and the sun; but for astronomical purposes it is more convenient to consider the earth and the "fixed stars" as taking part in the motion.

It is very important to bear in mind both of the bodies concerned in any particular motion, as otherwise misconception may arise. For example, a man sitting in a train is at rest if you consider the train and the man; but he is changing his place on the earth, so that he is moving when you bring the earth into question. Or suppose a man to be pushing a barge along a canal: he thrusts one end of a pole against the side of the canal, leans upon the other end, and walks towards the stern of the boat. The pole prevents him changing his place with respect to the earth, and, as he walks along the barge, his feet press the barge forward. Thus he is not moving as to the earth, but he is moving in the barge. In each of these cases we might say that the man was at rest and yet in motion; but the apparent contradiction disappears as soon as you make the complete statement, mentioning the two bodies concerned in each instance.

The last instance we will give to illustrate the importance of carefully stating the two bodies taking part in any motion shall be the rotation of the earth, to the ambiguity of which we alluded above. In fig. 3 the sun is represented by the point S. The earth is represented by the little circles numbered 1, 2, etc. We suppose the earth to pass round the sun the wrong way of the watch, and the circles show its successive positions. At the same time we suppose it to be spinning, also the wrong way of the watch, and to indicate this we have marked the same point on each circle; indeed, you may take this mark to represent an observer on the earth. Instead, however, of between 350 and 400 complete spins we have for simplicity supposed a very small number. It is not necessary to indicate the fixed stars in our diagram; they may be represented by the edges of the page.

The rotation of the earth.

Now let us count the turns when the sun is the second body in question. Notice that as the earth moves from 3 to 9 it makes one complete turn; the sun is directly above the observer at 3 and at 9, but not between. Another turn is completed while the earth passes from 9, 10, 11, . . . up to 3. So that if the sun is the second body, we should have just two complete turns.

But if you suppose the fixed stars to be the second body, then you will find there are *three* complete turns: one begins at 12 and finishes at 4; a second begins at 4 and finishes at 8; while the third begins at 8 and finishes at 12. Thus with respect to the stars there is just one more complete turn than with respect to the sun. This holds good no matter how fast the spinning goes on: there is one more turn when the stars are considered than when the sun is taken as the second body. We know, for example, that the earth spins round $365\frac{1}{4}$ times while it passes once round the sun—supposing the sun to be the second body concerned in the motion. In other words, there are $365\frac{1}{4}$ "sun-days" in a year. But there are $366\frac{1}{4}$ "star-days" in a year.

It will be an instructive exercise to make figures like fig. 3 for different cases. First, suppose the "earth" to pass round the "sun" the right way of the watch, and at the same time to be spinning the right way of the watch. You will then find that there is one more "star-day" than there are "sun-days" in the year. Indeed, you can at once get the figure for this case by observing fig. 3 in a looking-glass. Second, suppose the "earth" goes round the "sun" the right way and spins the wrong way of the watch. Then there will be one "star-day" less than there are "sun-days."

§ 8. Let us now take account of the *time* in which a motion is completed; let us consider *how fast* a body moves as well as in what direction it moves. We shall find that here, as before, the scientific mode of speaking only differs from our every-day form of speech by being more precise. The ideas are the same; only in science these ideas must be distinct, while in popular usage they are too often vague and indefinite.

Time.

It is usual to describe the quickness or velocity of a body by saying it moves so many miles an hour, so many yards a minute, so many feet a second, and so on. These are perfectly unobjectionable in themselves, but it is awkward to compare velocities expressed in different ways. We can see at once that a velocity of 24 miles an hour is twice as great as a velocity of 12 miles an hour; or that a velocity of 32 feet a second is a little greater than a velocity of $31\frac{1}{2}$ feet a second; but we cannot see at first sight what is the relation between a velocity of say 30 feet per second and 20 miles an hour. In order to avoid this difficulty of comparison—a difficulty which would become very serious in some cases—we shall choose one way of expressing a velocity, and keep to that; we shall always suppose velocities to be expressed in *feet per second*. If, for instance, it is said that the velocity of a body is 15, it is implied that the body would pass over 15 *feet* in a *second*, supposing its velocity did not change.

The process of changing from "miles per hour" to "feet per second," is very simple, and may be illustrated by an example. Say a train is moving at the rate of twenty miles per hour, how many feet does it pass over in a second? Now we have here the distance passed

An example.

in 1 hour = 20 miles = 105600 ft.,
" 1 minute = 105600 ft. $\div$ 60 = 1760 ft.,
" 1 second = 1760 ft. $\div$ 60 = $29\frac{1}{3}$ ft.;

so that "20 miles an hour" is the same as

$29\frac{1}{3}$ feet per second; and we may speak of it as a velocity of $29\frac{1}{3}$. By this method we can always express a velocity in feet per second; and a little skill in arithmetic will enable us to perform the reduction with very little trouble. For the future all velocities, unless otherwise stated at the time, will be expressed in this way.

§ 9. The process just described may very conveniently be indicated by an "equation." It is possible that some of my readers may find a brief explanation desirable; and as in some cases the use of equations will save a very large amount of verbal description, it will be worth while trying to master this paragraph. Supposing the velocity of a body not to change, this velocity is the number of feet passed over in one second; and the number of feet passed over in any number of seconds is found by multiplying the velocity by that number of seconds. If, for example, a body is moving with a velocity 10—in other words, if it passes over 10 feet in a second—then in 6 seconds it would pass over 60 feet. Now, instead of writing "the velocity of the body," let us write the single letter v; instead of "the number of seconds" let us write t, the initial letter of time; and instead of "the number of feet passed over by the body" let us write s, the initial letter of space. Then the above statement becomes

The use of equations.

s = v multiplied by t.

This is usually made shorter still by leaving out the words "multiplied by"; and we shall understand for the future that when two letters come together, like $v\ t$, without any mark between them, they are to be multiplied. Our equation then becomes

$$s = v\,t.$$

This equation may be put into two other forms—

$$v = \frac{s}{t} \text{ and } t = \frac{s}{v};$$

but these are really the same statement in new shapes. If, for instance, you say 6 is 3 times 2, or 3 is 6 divided by 2, or 2 is 6 divided by 3, you make the same statement, but each time in a different way. It is just the same with the three equations written above: they are simply three different ways of expressing one and the same fact; and it is only necessary to remember the first of them, though the second and third are at times more convenient.

From the second equation we have a rule for finding the velocity of a body: viz., divide the number of feet passed over (s) by the number of seconds (t). Take for example the case we have already worked out: what is the velocity of a body that passes over 20 miles in an hour? Here the number of feet is $20 \times 1760 \times 3$; the number of seconds is 60×60; so that the velocity

$$= \frac{20 \times 1760 \times 3}{60 \times 60}$$
$$= 29\tfrac{1}{3} \text{ as before.}$$

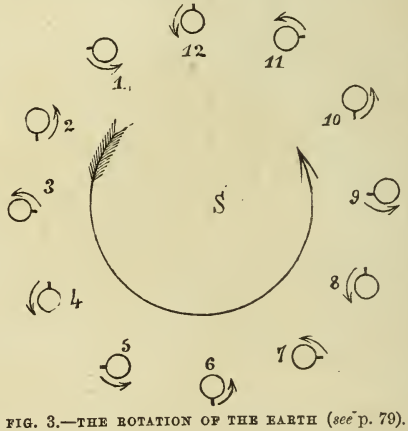


FIG. 3.—THE ROTATION OF THE EARTH (*see* p. 79).

ZOOLOGY.

III.

HABITS AND TRANSFORMATIONS OF ANIMALS.

STUDYING the whole of the facts that can be learned about any particular creature, we discover that it has a complex and peculiar grouping of characteristic actions, which we call its habits. These are by no means wholly concerned with its acquisition of food, but may have reference to many other conditions. We need only refer to the cat's habit of cleaning its fur, and the singing of birds, as examples of this. Many habits are specially concerned with the reproduction of the species and the rearing of young. How vast are the differences between animals as regards the care taken of their young—between the little songbird diligently feeding its young for many days, and the ostrich leaving its eggs to be hatched in the sand! Even among the highest class of animals there are found immense contrasts in this respect—the young of the kangaroo are born most imperfect, requiring to be fed and nurtured a long time before being able to run about, while the lamb or calf is able to run about as soon as born. Every peculiar habit, of course, implies a corresponding structure or faculty in the animal.

Habits.

Thus a true zoology will be engaged at every step in studying the fitness and correspondence of structure and function. When we see a habit or any noteworthy action, we say, By what kind of structure was this brought about? The discovery of a peculiar structure stimulates us to inquire into its possible uses. And, further, we are led to investigate the faculties by which these structures are controlled and these functions brought into play. By the same instinct we recognize the ability which most creatures have to perform the actions peculiar to them without having been taught directly, or ever

Adaptations of structure.

having seen them done. Can we trace any cause for the development of these instincts? or do they exist as they have always existed since the creation? Many animals teach their young various habits and practices, and these become as firmly implanted as the natural instincts. Other creatures, and especially those which are made use of by man, or which become his associates and companions, can not only be taught what they did not know by nature—that is to say, trained in special ways according to man's will—but in the variety of circumstances that may occur, they show a power of adapting themselves to the occasion, of remembering, reflecting, and reasoning in a way really similar to that employed by ourselves. Where is the boundary between instinct and reason in animals? Can they replace one another? Is there a limit to the capacities of the higher groups? What is the distinct separation between the rest of the animal creation and mankind? Here are questions full of the gravest interest, which must meet every one who sets himself to think upon the commonest occurrences.

ROCK KANGAROO. GREAT KANGAROO.

Mostly we see animals only in one phase or style of existence. The dog is always a dog with four legs: he does not show himself in different guise or with any strong contrasts of structure or faculties from the day of his birth. But in at any rate two sets of cases we have experience of startling changes in the external appearance and habits of the same individual in the course of his life. We see the young tadpole in spring swimming in the water with a long tail and tufted appendages from his head floating in the water and serving for breathing. In autumn the tail has been lost, the tufted gills also have disappeared, and the creature comes out on land as a frog or toad. Again, every one is familiar with caterpillars and grubs of all sorts, —some with legs by which they run about, and strong jaws with which they feed at a prodigious rate; some covered with masses of hair of resplendent colours; others destitute of feet, and motionless, or capable of only a sort of wriggling movement. We watch the caterpillar becoming a resting body, ceasing to move, perhaps spinning a cocoon of silk for a soft bed; and then, after a period of quiet slumber, his outer case opens, and he appears as a light winged creature, a butterfly, or a moth, or a fly, presenting the most startling dissimilarity to his earlier condition. These are the mos otbvious cases of transformation in the animal kingdom. But in looking more closely at natural history, the student will find that these are but a sample of events which are most important in almost every class of the animal kingdom. The lobster and the crab were once slight creatures with but few legs and very differently shaped bodies. The oyster was a minute free-swimmer; the barnacle had ordinary walking and swimming legs, and was destitute of a long stalk; the sea-urchin in its strong calcareous box has developed out of a soft organism whose shape is such that it has been most aptly compared to a painter's easel; the permanently fixed coral and sponge moved about freely as minute creatures, choosing their place of habitation.

Transformations.

Some animals are parasites upon others, getting their food by their destruction, living on or inside them during some portion of their lives, while they may be free and capable of obtaining their own food at an earlier or later period. Some require two entertainers or hosts, each being associated with a particular portion of their

Parasites.

development; and they often can only proceed from one stage of growth to another if their first host should be eaten by their second. Truly the sound of the words "transformation" or "metamorphosis" is to the zoologist the signal which calls up a host of images of orderly and most interesting changes.

Names of Groups in Zoology.

Certain terms are needed by the zoologist to bring about an orderly arrangement of the animals he meets with; and we shall gain by defining them before we commence our review.

Species. To begin with the word *species*, so commonly used. In zoology it has a very definite application, which can be readily understood in its application to domestic animals. All the dogs familiar to us are members of one species; so also all the cats. A species is thus composed of a multitude of individuals, no two of which are exactly alike, and which may differ in many characters. They have essentially the same structure and nature, so that we should readily discern their similarity, and they as a rule readily couple with one another. The kinds or breeds of dogs that we meet with

Variety. are so many *varieties* of the same species; they may remain perfectly distinct and distinguishable by special characters, if carefully bred, but cross breeds are readily produced.

When we compare a cat with a lion or a tiger, we see at once that there is a resemblance between them: the general form of the body, the shape of the feet and action of the claws, the cast of the countenance, the natural food, all

Genus. indicate some relationship, and we agree that, taking a large view, they are all cats. While they differ in important respects, yet they agree in so many that they are recognized as forming a group or kind, to which the term *genus* is applied.

When we discover one genus after another closely approaching, but yet each genus differing by something more important than the things which mark out species, they are grouped together under a higher and more comprehen-

Family. sive name—that of family. Then, beyond this, there is a broad distinction to be met with in much more considerable groups, shown by different structure of teeth, or legs, it may be, and a special kind of food. The animals with hoofs, being vegetable-

Order. feeders, are put into an *order* of hoofed animals, contrasted with those which have claws and sharp cutting teeth, and which are flesh-eaters, forming the carnivorous order.

A collection of orders agreeing in certain very important features, such as the possession of feathers or the suckling of their young,

Class. constitutes a *class*, which is one of the highest divisions. The number of classes is much fewer than the number of orders; orders are more numerous than families, and these again than genera; while species form a vast multitude, composed of an incalculable number of individuals.

On comparing the classes together, we find the greatest divergence in outward form and internal structure. There are numerous plans or styles of structure, with corresponding variations in organs and in their arrangements. These it will be best to learn something of gradually, beginning with animals of a structure most familiar to us, and nearest to ourselves. For the general plan of organism of one of the higher animals we must refer to the articles on Human Anatomy in succeeding pages of the Universal Instructor, and we shall suppose that our readers have already acquired a general idea of the putting together of a bodily structure, its combinations of skeleton, muscles, brain, nerves, organs of sense, and blood. Here we shall begin with a study of the animal group nearest to ourselves in bodily organization and outward form, first giving some description of the characters of the greater groups to which they belong.

Plans of organisation.

XXVIII.

The Verb (*continued*).

§ 185. *Number* and *Person*.
§ 186. Inflexion denoting person.
§ 187. Verbs classified according to inflexion.
§ 188. Strong verbs.
§ 189. Weak verbs.
§ 190. Contracted verbs.
§ 191. "Simple" and "complex" orders in Old English.
§ 192. *Strong* verbs, Division I.
§ 193. Strong verbs, Division II.

§ 185. **Number** and **Person.**—Verbs are modified to correspond with the *number*, singular or plural, and the *person*, first, second, or third, of the subject. Thus in "I love Tom," *love* is said to be in the singular number, and the first person, to agree with the subject *I;* in "she loves me," *loves* is of the singular number, and third person, to agree with the subject *she*, which is of that number and person. So it is important to remember that the number and person of the verb depend on the subject. In Old English there were numerous changes in the verb-form to denote person and number, but they have been lost by degrees, so that we now retain but two person-endings in the singular number of the indicative mood. An exception must be made for the verb *to be*, which keeps some inflexions of number.

§ 186. The person-endings are the remains of what were once pronouns. The ending proper to the first person, *m*, as in the pronoun *me*, is now only found in *am;* second person, *est*, or shortened *st*, lov*est*, did*st*,—in a few words, as wil*t*, shal*t*, ar*t*, it is *t* only, the most ancient form of the suffix; third person, *s*, or the old form *th* (which belongs to the third personal pronoun, as in *th*ey, *th*at), has and ha*th*, cries and crie*th*.

The Old English ending *ath* or *eth*, for the third person *singular* of the present indicative, became softened to *s* by means of the Northern dialect in

early times (11th century). But the *th* remained also in use, and is still familiar to us in the Bible, and less frequently in Shakespeare: "Thus sai*th* the Lord," "he that flee*th* from the fear," "he that gett*eth* up out of the pit," "the people of Chemosh perish*eth*" (Jer. xlviii. 40-46). "The noble Brutus ha*th* told you" (*Julius Cæsar*). The Old English ending for the third person *plural* of the same tense was *ath*, which also was changed in the Northern to *s*, in the Midland it became *en*, while the Southern dialect retained the *th* (13th and 14th centuries). See before, §§ 62, 63.

The four notions of mood, tense, number, and person belong to active, passive, and all other verbs; but the auxiliaries and impersonal verbs cannot be used in all the forms, and are therefore called *Defective*.

§ 187. We have now looked at the principal notions that can attach to a verb. As we have seen, there are few inflexions; but one of these—that of the past tense—is so important that nearly the whole body of verbs is classified according to it; and before we can marshal a verb through all the notions we have just gone through, and thus form what is called a *conjugation* (or *yoking-together*), this Classification according to Inflexion must be examined.

§ 188. **Strong** and **Weak Verbs.**—Verbs are classified as *Strong* and *Weak*, according to the form of the *principal parts*, which are the *present* and *past indefinite* of the indicative mood of the active verb, and the *passive participle;* as *I love, I loved, loved.* There is no special meaning in the words strong and weak; the name does for want of a better, and will not be so apt to mislead as the names regular and irregular, or modern and old, which some have proposed. Verbs of the STRONG *conjugation* are those in which there is a *vowel change* between the present and past tenses, as *run, ran, run,* or in all three parts, as *write, wrote, written.* All passive participles of such verbs formerly ended in *en*, but now many have lost the ending, or it is contracted into *n*.

§ 189. Verbs of the WEAK *conjugation* form the past tense and the passive participle by the *addition* of *d* or *t; e* frequently comes in as a connecting vowel, pronounced when the verb ends in *d* or *t*, to separate the dentals, as in *planted;* dropped in all other cases, as in *loved, locked,* which we pronounce *lovd, lockt.*

§ 190. Some verbs, which look at first sight like members of the strong conjugation, are found really to belong to the weak verbs when we come to know something of their formation; they are called *Contracted* verbs. Such are *buy, bought; creep, crept.*

Various changes have taken place among the strong verbs. There were many more in the old language than remain to us now; some have become conjugated in part, others altogether, like the weak verbs. The tendency of the language is to simplify forms: as with the nouns, leading all towards the plural in *s*, so with the verbs, when new ones are made or special forms have been forgotten, the easiest and uniform mode of inflexion has been adopted, and has survived as the living form for all new or doubtful words; they have received the *ed, d,* or *t* of the past tense and participle.

§ 191. In Old English the verbs were of two Orders: the *Simple,* which formed its past by the addition of *ode* or *ede, de* or *te;* and the *Complex,* in which the past tense of one syllable made a vowel-change, while the passive participle ended in *en*.

The Simple order comprised three classes, one of which changed the vowel in the past tense and participle, and also added the *d* or *t*. Examples of these three will render the modern conjugations easier to comprehend.

	Present.	*Past.*	*Pass. Part.*
I.	lufige, *love*	lufode, *loved*	lufod, *loved*
	herige, *praise*	herede, *praised*	hered, *praised*
II.	hȳre, *hear*	hȳrde, *heard*	hȳred, *heard*
III.	telle, *tell*	tealde, *told*	teald, *told*

The changes for person and number in these verbs were simple, and were made by *additions* to the root of the word, not by change of the root-vowel. Our Weak verbs have come from this order; the contracted verbs are some of those included in the second and third classes.

In the Complex order were several classes, according to changes made from the original root-vowel to distinguish not only tense, but also person and number, like many modern German verbs. From this order come our Strong verbs, only we have lost the changes to show person and number.

§ 192. It is convenient to arrange the strong verbs in two divisions of seven groups, which nearly correspond to the six classes of two conjugations belonging to the old "complex order." Some examples will help the student to find out more for himself in each class; an alphabetical list will be given a little further on. Some philologists tell us that originally the past of all these verbs, in English and other Indo-European languages, was formed by a repetition of the first syllable of the present, as *ca-do, ceci-di,* in Latin (I fall, I have fallen); the pronunciation of one syllable after the other caused a modification in the vowel of the first syllable, then the second syllable not being needed to mark the tense, because the changed vowel did it, gradually dropped away. This process took place with our language before the time of the oldest English, yet there are a few traces by which, and by comparison with other kindred tongues, scholars can point out certain verbs known to have been reduplicated; one instance even remaining to us in modern English—the verb *do, did.*

In Class I. there is no change in the passive participle.* In Class II. there is change in both past tense and passive participle.* The others are grouped according to vowel change.

Div. I. Cl. I.

Present.	*Past.*	*Participle.*
blow	blew	blown
crow	[crew] crowed	[crown] crowed
grow	grew	grown
know	knew	known
mow	mowed	mown
sow	[sew]	sown
throw	threw	thrown
hew	[hew]	hewed, hewn
fall	fell	fallen
hang	hung	hung
hold	held	held, holden
beat	beat	beaten

The words between [] were formerly in use;

* These two classes are placed in a separate division by Dr. Morris, because they are those verbs in which he has been able to trace the origin of the past tenses to early reduplicated forms.

moved is a modern weak past. *Hang* in Old Eng. was *hange, hêng, hangen*; hence it belongs to this class.* Several other verbs once were ranged in like manner, among which were *sleep, sweep, weep, leap,* and *walk,* their past tenses being *slep, swep, wep, lep* or *leep, welk.* Ex. : "Thre daies *slep* he" (*O. E. Misc.* p. 24), "And than we *welk* forth" (*Paston letters*).

Cl. II.

Present.	*Past.*	*Pass. Part.*
begin	began	begun
cling	clang	clung
climb	clomb	climbed[modern]
drink	drank	drunk
swim	swam	swum
ring	rang	rung
swing	swang	swung
wring	[wrang]	wrung
find	found	found
fight	fought	fought [foughten]
grind	ground	ground
help	[holp] helped	[holpen]
melt	[molt] melted	molten, melted
swell	[swal]	swollen
ding	[dang]	
wink	[wonk] winked	
burst	[barst] burst	[borsten] burst

Here we see *burst*, which had formerly three forms, now reduced to one, and *help, melt*, etc., have taken weak forms. In *carve*, formerly kerve, carf, korven, the modern verb has formed itself on the past tense of old times ; Chaucer's young squire "*carf* byforn his fader at the table."

§ 193. Of the other groups of Division II. we place together a few specimens.

Present.	*Past.*	*Pass. Part.*
Cl. I.		
bear	bore [bare]	born, borne
break	broke [brake]	broken
shear	sheared	shorn
speak	spoke [spake]	spoken
come	came	come
Cl. II.		
bid	bade, bid	bidden
lie	lay†	lain
sit	sat	sat
eat	ate	eaten
get	[gat] got	gotten‡, got
see	saw	seen
	quoth	
	was	
Cl. III.		
wake	woke	woke
forsake	forsook	forsaken
stand	stood	stood
swear	swore [sware]	sworn
heave	hove	hoven
wash	[wesh]	[un]washen

* To kill by hanging we use *hanged* for both past tense and participle, as "went and *hanged* himself" (Matt. xxvii. 5) ; in the phrase "a piece of hung beef" it is the participle *hungen* minus the *en*.

† This is the intransitive verb. The active transitive is *lay, laid, laid* : "the hen laid eggs," "lay the cloth." The use of the two is often mistaken.

‡ This is not often used, but I have heard it on the lips of an elderly lady native of Bristol.

Cl. IV.

bite	bit	bitten
ride	rode	ridden
drive	drove	driven
smite	smote	smitten
arise	arose	arisen
write	wrote	written
strike	struck	stricken, struck
chide	[chode] chid	chidden

Cl. V.

fly	flew	flown
freeze	froze	frozen
seethe	seethed [sod]	sodden
cleave	clove	cloven
lose	lost (mod.)	[lorn] forlorn

The pass. participles *born, torn*, etc., are contracted from *boren, toren*, etc. Such words as *bare, brake, spake*, were formerly in use, but as in several other verbs (*e.g.* strike) a confusion appears to have crept in between the past tense and the participle, so that they had a tendency to grow alike : thus *broke* came to be used instead of *brake*. "Then *spake* Jesus," "they *brake* not his legs" (John xix. 33) ; now we say "I *spoke* to him," "she *broke* her heart." Sometimes, too, we find that the participle dropped the final *n* or even *en*, as in Shakespeare :

"His red colour hath *forsook* his cheeks."
Richard III., Act II., sc. i.

"You've ungently, Brutus,
Stole from my bed."—*Julius Cæsar*, Act II., sc. i.

Quoth and *was* are the only parts remaining of two old verbs : *quoth* is now used as a past tense ; *was* has been combined with *to be*.

XXXI.

Irregular Verbs.

The following verbs are irregular—that is, are conjugated each after its own way, and not after any one of the four regular conjugations : *Possum* (*potis*, able, *sum*, I am), to be able ; *volo*, to be willing ; *nolo* (*non volo*), to be unwilling ; *malo* (*magis volo*), to be more willing, and so prefer ; *fero*, to bear ; *eo*, to go ; *fio*, to be made or become ; *queo*, to be able ; *nequeo* (*ne queo*), to be unable ; and *edo*, to eat.

1. **Possum, pŏtuī, possĕ,** *to be able* ; *can.*

	INDIC.	SUBJ. or CONJ.		INDIC.	SUBJ. or CONJ.
	1. *Present.*			2. *Future-Simple.*	
S.	**possum**	**possim**	*S.*	**pŏtĕro**	(wanting)
	pŏtēs	**possīs**		**pŏtĕrīs**	
	pŏtest	**possĭt**		**pŏtĕrĭt**	
P.	**possŭmŭs**	**possīmŭs**	*P.*	**pŏtĕrĭmŭs**	
	pŏtestĭs	**possītĭs**		**pŏtĕrĭtĭs**	
	possunt	**possint**		**pŏtĕrunt**	

INDIC.	SUBJ. or CONJ.
3. *Imperfect.*	
S. pŏtĕram	possem
pŏtĕrās	possēs
pŏtĕrăt	possĕt
P. pŏtĕrā-mŭs	possēmus
pŏtĕrātĭs	possētĭs
pŏtĕrant	possent
4. *Perfect.*	
S. pŏtuī	pŏtuĕrim
pŏtuistī	pŏtuĕrīs
pŏtuĭt	pŏtuĕrĭt
P. pŏtuĭmŭs	pŏtuĕri-mŭs
pŏtuistĭs	pŏtuĕri-tĭs
pŏtuērunt (ērĕ)	pŏtuĕr-int

INDIC.	SUBJ. or CONJ.
5. *Future-Perfect.*	
S. pŏtuĕro	(wanting)
pŏtuĕrĭs	
pŏtuĕrĭt	
P. pŏtuĕrimŭs	
pŏtuĕrĭtĭs	
pŏtuĕrint	
6. *Pluperfect.*	
S. pŏtuĕram	pŏtuissem
pŏtuĕrās	pŏtuissēs
pŏtuĕrăt	pŏtuissĕt
P. pŏtuĕrā-mŭs	pŏtuissē-mŭs
pŏtuĕrā-tĭs	pŏtuissē-tĭs
pŏtuĕr-ant	pŏtuiss-ent

INFINITIVE.

Pres. and Imp. possĕ. *Perf. and Plup.* pŏtuissĕ. *Future* wanting. (Participle **pŏtens**, used only as adjective, powerful.)

Observe that the composition of *possum* (of *sum*, and *potis*, able) explains its seeming irregularities; for example, the future *potero* is a contracted form of *potis ero;* the perfect, *potui*, of *potes fui;* the pluperfect, *poteram*, of *potes fueram.*

Vŏlo, Nōlo, and **Mālo** are thus conjugated :—

INDICATIVE.

1. *Present.*

Sing.	vŏlo	nōlo	mālo
	vīs	nōn vīs	māvīs
	vult	nōn vult	māvult
Plur.	vŏlŭmŭs	nōlŭmŭs	mālŭmŭs
	vultĭs	nōn vultĭs	māvultĭs
	vŏlunt	nōlunt	mālunt

2. *Future-Simple.*

Sing.	vŏlam	nōlam	mālam
	vŏlēs	nōlēs	mālēs
	vŏlĕt	nōlĕt	mālĕt
Plur.	vŏlēmŭs	nōlēmŭs	mālēmŭs
	vŏlētĭs	nōlētĭs	mālētĭs
	vŏlent	nōlent	mālent

3. *Imperfect.*

Sing.	vŏlēbam	nōlēbam	mālēbam
	vŏlēbās	nōlēbās	mālēbās
	vŏlēbăt	nōlēbăt	mālēbăt
Plur.	vŏlēbāmŭs	nōlēbāmŭs	mālēbāmŭs
	vŏlēbātĭs	nōlēbātĭs	mālēbātĭs
	vŏlēbant	nōlēbant	mālēbant

4. *Perfect.*

Sing.	vŏluī	nōluī	māluī
	vŏluistī	nōluistī	māluistī
	vŏluĭt	nōluĭt	māluĭt
Plur.	vŏluĭmŭs	nōluĭmŭs	māluĭmŭs
	vŏluistĭs	nōluistĭs	māluistĭs
	vŏluērunt or -uērĕ	nōluērunt or uērĕ	māluērunt or -uērĕ

5. *Future-Perfect.*

Sing.	vŏluĕro	nōluĕro	māluĕro
	vŏluĕrĭs	nōluĕrĭs	māluĕrĭs
	vŏluĕrĭt	nōluĕrĭt	māluĕrĭt
Plur.	vŏluĕrimŭs	nōluĕrimŭs	māluĕrimŭs
	vŏluĕrĭtĭs	nōluĕrĭtĭs	māluĕrĭtĭs
	vŏluĕrint	nōluĕrint	māluĕrint

6. *Pluperfect.*

Sing.	vŏluĕram	nōluĕram	māluĕram
	vŏluĕrās	nōluĕrās	māluĕrās
	vŏluĕrăt	nōluĕrăt	māluĕrăt
Plur.	vŏluĕrāmŭs	nōluĕrāmŭs	māluĕrāmŭs
	vŏluĕrātĭs	nōluĕrātĭs	māluĕrātĭs
	vŏluĕrant	nōluĕrant	māluĕrant

SUBJUNCTIVE OR CONJUNCTIVE.

1. *Present.*

Sing.	vĕlim	nōlim	mālim
	vĕlīs	nōlīs	mālīs
	vĕlĭt	nōlĭt	mālĭt
Plur.	vĕlīmŭs	nōlīmŭs	mālīmus
	vĕlītĭs	nōlītĭs	mālītĭs
	vĕlint	nōlint	mālint

2. *Imperfect.*

Sing.	vellem	nollem	mallem
	vellēs	nollēs	mallēs
	vellĕt	nollĕt	mallĕt
Plur.	vellēmŭs	nollēmŭs	mallēmŭs
	vellētĭs	nollētĭs	mallētĭs
	vellent	nollent	mallent

3. *Perfect.*

Sing.	vŏluĕrim	nōluĕrim	māluĕrim
	vŏluĕrīs	nōluĕrīs	māluĕrīs
	vŏluĕrĭt	nōluĕrĭt	māluĕrĭt
Plur.	voluĕrimŭs	nōluĕrimŭs	māluĕrimŭs
	vŏluĕritĭs	nōluĕritĭs	māluĕritĭs
	vŏluĕrint	nōluĕrint	māluĕrint

4. *Pluperfect.*

Sing.	vŏluissem	nōluissem	māluissem
	vŏluissēs	nōluissēs	māluissēs
	vŏluissĕt	nōluissĕt	māluissĕt
Plur.	vŏluissēmŭs	nōluissēmŭs	māluissē-mŭs
	vŏluissētĭs	nōluissētĭs	māluissētĭs
	vŏluissent	nōluissent	māluissent

IMPERATIVE.

Present.

(wanting)	nōlī	(wanting)
	nōlitĕ	

Future.

S.	nōlito	*P.*	nōlitōtĕ
	nōlito		nōlunto

INFINITIVE.

Present and Imperfect.

velle	nolle	malle

Perfect and Pluperfect.

vŏluisse	nōluisse	māluisse

Present Participles.

vŏlens	nōlens	(wanting, but place supplied by *lubens*, willing)

Fĕro, tŭli, ferrĕ, lātum, *to bear, carry, endure.*

I. ACTIVE VOICE.

INDIC.	SUBJ.
1. *Present.*	
S. fĕro	fĕram
fers	fĕrās
fert	fĕrăt
P. fĕrĭmŭs	fĕrāmŭs
fertĭs	fĕrātĭs
fĕrunt	fĕrant
2. *Future-Simple.*	
S. fĕram	(wanting)
fĕrēs	
fĕrēt	
P. fĕrēmŭs	
fĕrētĭs	
fĕrent	
3. *Imperfect.*	
S. fĕrēbam	ferrem
fĕrēbās	ferrēs
fĕrēbăt	ferrēt
P. fĕrēbāmŭs	ferrēmŭs
fĕrēbātĭs	ferrētis
fĕrēbant	ferrent
4. *Perfect.*	
S. tŭli	tŭlĕrim
tŭlisti	tŭlĕrĭs
tŭlĭt	tŭlĕrĭt
P. tŭlĭmŭs	tŭlĕrimŭs
tŭlistĭs	tŭlĕritĭs
tŭlĕrunt or ērĕ	tŭlĕrint
5. *Future-Perfect.*	
S. tŭlĕro	(wanting)
tŭlĕrĭs	
tŭlĕrĭt	
P. tŭlĕrimŭs	
tŭlĕritĭs	
tŭlĕrint	
6. *Pluperfect.*	
S. tŭleram	tŭlissem
tŭlĕrās	tŭlissēs
tŭlĕrăt	tŭlissĕt
P. tŭlĕrāmŭs	tŭlissēmŭs
tŭlĕrātĭs	tŭlissētĭs
tŭlĕrant	tŭlissent

IMPERATIVE.

Present.		*Future.*	
S. fer	*P.* fertŏ	*S.* ferto	*P.* fertōtĕ
		ferto	fĕrunto

INFINITIVE.

Pres., Imp. ferrĕ
Perf., Plup. tŭlissĕ
Fut. lātūrŭs essĕ
Part. Pres. fĕrens
Fut. lātūrŭs (ă, um)
Supines. lātum, lātŭ
Gerund, Gen. fĕrendī, etc.

II. PASSIVE VOICE.

INDIC.	SUBJ.
1. *Present.*	
S. fĕrŏr	fĕrăr
fĕrrĭs, -rĕ	fĕrārĭs, -ārĕ
fĕrtŭr	fĕrātŭr
P. fĕrĭmŭr	fĕrāmŭr
fĕrĭmĭnī	fĕrāmĭnī
fĕruntŭr	fĕrantŭr
2. *Future-Simple.*	
S. fĕrăr	(wanting)
fĕrērĭs, ērĕ	
fĕrētŭr	
P. fĕrēmŭr	
fĕrēmĭnī	
fĕrentŭr	
3. *Imperfect.*	
S. fĕrēbăr	ferrĕr
fĕrēbārĭs, -ārĕ	ferrērĭs, ērĕ
fĕrēbātŭr	ferrētur
P. fĕrēbāmŭr	ferrēmŭr
fĕrēbāmĭnī	ferrēmĭnī
fĕrēbantŭr	ferrentŭr
4. *Perfect.*	
S. lātŭs sum	lātŭs sim
lātŭs es	lātŭs sīs
lātŭs est	lātŭs sĭt
P. lātī sŭmŭs	lāti sīmŭs
lātī estĭs	lātī sītĭs
lātī sunt	lātī sint
5. *Future-Perfect.*	
S. lātŭs ĕro	(wanting)
lātŭs ĕrĭs	
lātŭs ĕrĭt	
P. lātī ĕrĭmŭs	
lātī ĕrĭtĭs	
lātī ĕrunt	
6. *Pluperfect.*	
S. lātus ĕram	lātŭs essēm
lātŭs ĕrās	lātŭs sēs
lātŭs ĕrăt	lātŭs sĕt
P. lātī ĕrāmŭs	lātī essēmŭs
lātī ĕrātĭs	lātī essētĭs
lātī ĕrănt	lātī essent

IMPERATIVE.

Present.		*Future.*	
S. ferrĕ	*P.* fĕrĭmĭni		
S. fertŏr	fertŏr	*P.* fĕruntŏr	

INFINITIVE.

Pres., Imp. ferri
Perf., Plup. lātŭs essĕ
Fut. lātum īrī
Part. Perf. lātus (ă, um)
Gerundive. fĕrendŭs (ă, um)

The compounds of *fĕro* are conjugated in the same way, as:—

affĕro (*ad, fero*), attŭli, allātum, afferre, to bring to.
aufĕro (*ab, fero*), abstŭli, ablātum, auferre, to carry away.
effĕro (*ex, fero*), extŭli, ēlātum, efferre, to carry out.
infĕro (*in. fero*), intŭli, illatum, inferre, to carry into.
offĕro (*ob, fero*), obtuli, oblatum, offerre, to offer.
perfĕro (*per, fero*), pertŭli, perlatum, perferre, to bear through.
præfĕro (*præ, fero*), prætŭli, prælātum, præferre, to prefer.
rĕfĕro (*re*, back, *fero*), rĕtŭli, relātum, rĕferre, to bring back.

Observe that *rĕfert*, it concerns, and *retŭli*, the impersonal, is from *rem*, business, and *fert*, brings.

Eo, īvī, ĭtum, īrĕ, *to go.*

INDICATIVE.	SUBJUNCTIVE.
1. *Present.*	
S. eo *P.* imus	*S.* eam *P.* eamus
is itis	eas eatis
it eunt	eat eant
2. *Future.*	
S. ibo	iturus sim
ibis	iturus sis
ibit	iturus sit
P. ibimus	ituri simus
ibitis	ituri sitis
ibunt	ituri sint
3. *Imperfect.*	
S. ibam	irem
ibas	irēs
ibăt	iret
P. ibāmŭs	irēmŭs
ibātĭs	irētis
ibant	irent
4. *Perfect.*	
S. ivi or iī	iverim or ierim
ivisti, etc.	iveris or ieris
ivit, etc.	iverit, etc.
P. ivimus	iverimŭs, etc.
ivistis	iverītis, etc.
iverunt or ērĕ	iverint
5. *Future-Perfect.*	
S. ivero or iero	(wanting)
iveris or ieris	
iverit, etc.	
P. iverimus, etc.	
iveritis, etc.	
iverint, etc.	

6. *Pluperfect.*

S. iveram or ieram	ivissem or issem
ivĕrās, etc.	ivissēs, etc.
ivĕrăt, etc.	ivissĕt, etc.
P. ivĕrāmŭs, etc.	ivissēmŭs, etc.
ivĕrātĭs, etc.	ivissētĭs, etc.
ivĕrant, etc.	ivissent, etc.

IMPERATIVE.

Pres. ī		*Fut.* ītō	ītōtĕ
ītŏ		ītō	īuntō

INFINITIVE.

Pres., Imp. īrĕ
Perf., Plup. īvissĕ, īissĕ, or issĕ
Fut. ītūrus essĕ
Part. Pres. ĭens (*Gen.* ĕuntĭs)
Fut. ĭtūrŭs (ă, um)
Gerund, Gen. ĕundi, etc.
Supine, ĭtum

The following compounds of *eo* are conjugated like *eo*, but observe that the perfect in *ĭī* is to be preferred generally to the form in *ivi*.

ăbeo, ăbīvī and ăbiī, abĭtum, to go away.
ădeo, ivi and ii, ĭtum, to go to.
coeo, ivi and iī, ĭtum, to go or come together.

So also *exeo*, to go out; *ineo*, to go in; *intereo*, to perish; *obeo*, to meet (death), and so to die; *præeo*, to go before; *prætereo*, to go beyond or pass by; *rĕdĕo*, to return; *subeo*, to go under or go from beneath, and so upwards; *transeo*, to cross over. Observe also that *quĕo*, and its compound *nĕquĕo*, to be unable, is conjugated like *eo*.

Fīo, factŭs sum, fĭĕrī, *to become*, or *be made, to happen.*

INDICATIVE. SUBJUNCTIVE.

1. *Present.*

S. fīo	*P.* [fīmŭs]	*S.* fīam	*P.* fīāmŭs
fīs	[fītĭs]	fīas	fīātĭs
fīt or fĭt	fīunt	fīat	fīant

2. *Future.*

S. fīam	*P.* fīēmus	(wanting)
fīēs	fīētĭs	
fīet	fīent	

3. *Imperfect.*

S. fīēbam	*P.* fīēbāmŭs	*S.* fīĕrem	*P.* fīĕrēmus
fīēbās	fīēbātĭs	fīĕrēs	fīĕrētis
fīēbăt	fīēbant	fīĕrĕt	fīĕrent

4. *Perfect.*

factŭs sum, etc. factŭs sim, etc.

5. *Future-Perfect.*

factŭs ĕro, etc. (wanting)

6. *Pluperfect.*

factŭs ĕram, etc. factŭs essem, etc.

IMPERATIVE.

Present, fī, fītĕ

INFINITIVE.

Pres., Imp. fĭĕrī
Perf., Plup. factŭs essĕ
Fut. factum īrī
Part. Perf. factŭs (ă, um)
Gerund, făciendŭs (ă, um)

Edō, I eat, often changes some of its forms as follows:—

Pres., 2nd pers. sing. *ĕdīs* or *ēs;* 3rd pers. sing. *ĕdĭt* or *est;* Infin. *ĕdĕrĕ* or *essĕ;* Imperf. conj., *ĕdĕrem* or *essem.*

Pres. conj., *ĕdim, ĕdis, ĕdĭt,* is used. Other forms are regular.

Self-Examination Questions and Exercises.

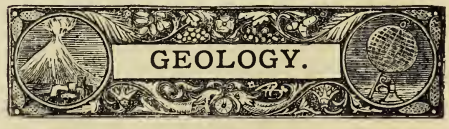
Conjugate *possum, volo, nolo, malo, eo, fio,* and *fero.* Account for the apparent irregularity of *possum* in the formation of its tenses. Derive *malo, nolo, nequeo.* What part of these irregular verbs are defective? Write out a list of the compounds of *eo* and *fero,* and state how they are conjugated. Distinguish *rĕfert* and *rĕfert.* Give the irregular forms of *edo*, to eat.

Translate into English:—

Ad urbem propter tantam multitudinem exire non poterant. Quandò vos e castris hominum exibitis? Malum nuntium affere noli. Modus exeundi non multum mirandus est. Me pudet tanta spolia auferre sine ullo prœlio. Duo tropœa belli e duobus hostibus abstulit. Omnia non possumus omnes. Mihi certandum est, si tot prœmia doctrinæ auferre mihi liceat. In pugnâ cum hostibus fortiter certans summâ laude periit. Patriæ bellum crudelissimum hic vir imprudens intulerat. His interfuisse rebus neque me neque te decet. Ad vos, consules, maxime attenet reipublicæ consulere, id quod facile pŏteritis. Bene mori potius quàm male vivere malebat. Poeta nascitur, non fit. Annorum præteritorum jam oblivescere. Imperator cito obiit. Poma cocta potius quàm cruda edere præstat. Fer merum vinum, quod opto. Num se perdere vult? Nuntium hostibus allaturus a portis exiit.

Translate into Latin:—

They preferred to die fighting than to go out of the city of their fathers. Be unwilling to perish on account of an unworthy king. Bring to your mother, O boy, the water she sent you to carry to her. I am ashamed of the folly, which you are well able to give up. These things are made with the greatest skill. These impious soldiers preferred to wage (*say* to bring about) a most cruel and unjust war against their country. "Will you ever be able," quoth he, "to deliver this land from its cruel lords?" I will not bear their indignation with patience.



XXIII.

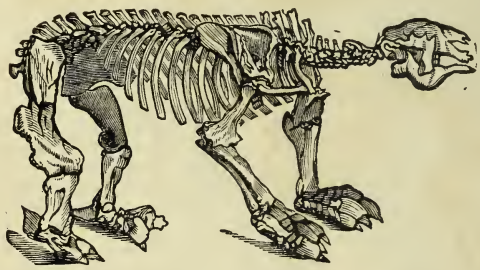
PLIOCENE AND POST-PLIOCENE (*continued*).

TURNING to the continental land of Europe and Asia, of which Great Britain really forms a part, we find stronger evidence than that mentioned in our last article of the long

duration of the Tertiary period. "The nummulitic limestone (Middle Tertiary) of the Swiss Alps," says Sir Charles Lyell, "rises to more than 10,000 feet above the level of the sea, and attains here and in other mountain chains a thickness of several thousand feet. It may be said to play a far more conspicuous part than any other Tertiary group in the solid framework of the earth's crust, whether in Europe, Asia, or Africa. It occurs in Algeria and Morocco, and has been traced from Egypt (where it was largely quarried of old, for the building of the pyramids) into Asia Minor, and across Persia by Bagdad to the mouths of the Indus. It has been observed not only in Cutch, but in the mountain ranges which separate Scinde from Persia, and which form the passes leading to Cabul; and it has been followed still farther eastward into India, as far as eastern Bengal and the frontiers of China. . . . All the mountain chains such as the Alps, Pyrenees, Carpathians and Himalayas, into the composition of whose central and loftiest points the nummulitic structure enters bodily, could have no existence till after the Middle Eocene period." The elevation of the Alps was probably commenced during what Continental geologists call the Oligocene period, to which, as before remarked, Prof. Judd refers the fluvio-marine strata of the Hampshire basin, and was continued through the Miocene period, when the denudation that of course commenced with the first upward movements furnished the material laid down as Miocene strata in their neighbourhood.

Nummulitic limestone.

Elevation of the Alps, Pyrenees, Himalayas, etc., since its deposit.



MEGATHERIUM CUVIERI (*post-Pliocene*), S. AMERICA.

The Miocene deposits of the Continent are frequently rich in organic remains, and have furnished a fossil fauna and flora of the greatest interest. The Upper Miocene beds of Œningen in Switzerland have long been celebrated for their fossil leaves and fruits, with which occur also the remains of insects and fish and the bones of mammals and reptiles. These and similar fossils from other localities are accepted as evidence that the climate of Europe in Upper Miocene times was something more than mild and genial; warmer than that of the subsequent Pliocene times, though not tropical like that of early Tertiary periods.

The flora of the Miocene.

In the same manner we arrive at the conclusion that a similar climate existed in the north polar regions, during the Miocene period. From Iceland, Greenland, Spitzbergen, and Grinnell Land (81° 45′N.) fossil leaves and fruits of a flora identified as Miocene in character, and indicating very different conditions to anything now known in those regions, have been obtained. How this complete change has been brought about no one knows. What we do know is that the records of animal and vegetable life as far back as the Carboniferous period and of animal existence to the Upper Silurian, occur in the arctic regions in abundance; and fossiliferous strata have been traced to the most northerly point yet reached. Whether there has been a change in the direction of the earth's axis, or what other cause or causes have brought about the alteration, we do not know yet; though it is not to be imagined that the problem is insoluble. It may be as well to add that it has been urged that probably the Arctic fossil flora, though Miocene in character, may be Eocene or earlier in date, which may well be the case if, as also suggested, the Miocene flora of Europe came from the north.

Its occurrence in the Arctic regions.

The Pliocene deposits of the Continent—notably those belonging to the upper Val d'Arno, near Florence—have yielded many genera of flowering-plants which show that the climate was temperate; and, as might have been expected, the vegetation of the period, as far as we know it, is strikingly similar to that now living. As showing that the Pliocene period was one of considerable duration, it may be remarked that in Sicily the deposits belonging to the newer division cover nearly half the island, and are near Castrogiovanni three thousand feet in thickness.

Duration of the Pliocene period.

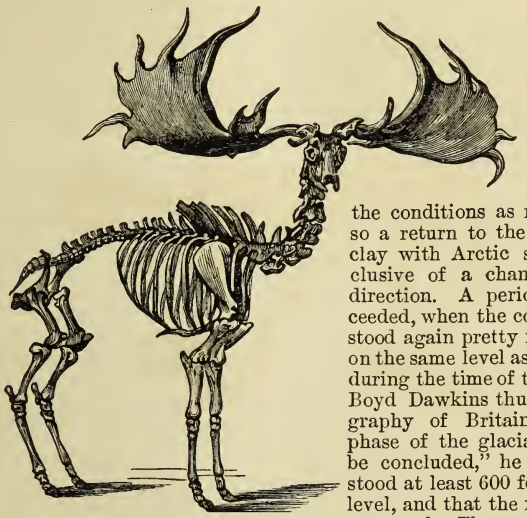
Post-Pliocene (or Pleistocene).

The sea in which the Pliocene deposits of England were laid down does not appear to have been very deep or to have extended far westward. At the close of the period an upward movement took place, by which England was united to Ireland and both to the Continent, and the greater part of the bed of the German Ocean became dry land. A comparatively trifling difference of level would be sufficient even now to produce the same results. If the whole country were raised one hundred fathoms (600 feet), Great Britain and Ireland would cease to be a group of islands, St. George's Channel would be a dry valley, and England would be joined to the continent of Europe both on the east and south, while a considerable tract of land would be added on the west and north,—how much may be seen by tracing the one-hundred fathom line, which is shown in most of the maps now published. Far greater movements than these have taken place since the period of which we are now speaking. In Wales we have shelly deposits of a later date raised on the mountain sides to at least 1350 feet; and there is a fair amount of evidence to show that the previous submergence of the land must have been some 2000 feet below the present level. The remains of the trees which grew on the plain now

Close of the Pliocene period.

covered by the German Ocean, and of the animals which lived thereon, are partially covered by glacial deposits, and partly laid bare, between high and low water marks, at Cromer, and for some distance along the coast of Norfolk; and the strata in which they are found are known, collectively, as the Cromer Forest Bed or the Norfolk Forest Bed. Amongst the trees which have been recognised as having flourished in this old forest are Scotch firs, spruces, yews, oaks, and birches; sloes and alders have also been found, with ferns, water-lilies, and other plants. The mammals were numerous, including three species of elephant (*E. meridionalis*, *E. antiquus*, and *E. primigenius*, or mammoth); two rhinoceri, a large extinct beaver, *Trogonotherium Cuvieri;* the common beaver, the machairodus (sabre-toothed lion), two species of bear, the urus, several species of deer, the wild boar, horse, wolf, fox, etc., etc.; but neither in the fauna nor flora is there anything to indicate the severity of climate characteristic of the glacial epoch which was then approaching. The temperature was no doubt lower than it had been even in the Pliocene period, but not so low as to interfere with the habits of a group of animals which we cannot imagine to have lived under conditions at all resembling those of an Arctic winter.

Forest bed of Norfolk.



CERVUS MEGACEROS (*MegacerosHibernicus*): IRISH ELK.—POST-PLIOCENE.

Minor changes of level * brought the Forest Bed period to a close, and a series of events occurred of which the history has been engraved upon the mountains and in the valleys by glaciers, and illustrated by boulder-clays and gravels. The greater part of Scotland, the Cumberland mountains, the Pennine chain, and the Welsh mountains, were covered by great systems of glaciers, which have left behind them the unmistakable record of their existence, and in many cases the direction in which these great ice rivers moved is also shown.

Glacial period.

To this succeeded a period of depression. The mountains formed islands, and the glaciers, descending to the sea, formed icebergs, which floated away bearing their burden of clay with sand and stones, as icebergs do now, and deposited them on the ocean bed. As a matter of fact, no boulder-clay has been found in this country south of a line drawn from the Thames to the Bristol Channel,—the reason of which is not quite so clear as might be wished. North of that line boulders and boulder-clays tell their own story. As the depression continued the sea grew deeper, and apparently the climate became more temperate. It was during this depression that the shelly gravels of Lancashire and Cheshire, and on Moel Tryfan in Carnarvonshire, and elsewhere, and what is designated the middle drift generally, were deposited; and it is from the height at which some of these deposits are now raised that we are enabled to judge of the extent of the depression which characterized the stage of the glacial period under notice.

Boulder-clays and drifts.

What is known as the Upper Boulder Clay is considered to be sufficient evidence of the return, for a time, of the severe climatal conditions of the earlier period. Just as the deposits of shingle and sand, and the presence of shells not characteristic of a severe climate, are looked upon as good evidence of the amelioration of the conditions as regards temperature, so a return to the deposit of boulder-clay with Arctic shells is fairly conclusive of a change in the opposite direction. A period of elevation succeeded, when the country stood again pretty nearly on the same level as it did during the time of the Forest Bed. Mr. Boyd Dawkins thus sketches the geography of Britain during this later phase of the glacial epoch. "It may be concluded," he says, "that Britain stood at least 600 feet above its present level, and that the rivers of our eastern coast—the Thames, Medway, Humber, Tyne, and others—joined the Rhine, the Weser and the Elbe, to form a river flowing through the valley of the German Ocean . . . . In like manner the rivers of the south of England and of the north of France formed a great river, flowing past the Channel Islands, due west, into the Atlantic; and the Severn united with the rivers of the south of Ireland; while those to the east of Ireland joined the Dee, Mersey, Ribble, and Lune, as well as those of Western Scotland, ultimately reaching the Atlantic to the west of the Hebrides . . . . The tract of low undulating land which surrounded Britain and Ireland on every side consisted not merely of rich hill, valley and plain, but also of marsh land studded with lakes, like the meres of Norfolk, now indicated by the deeper soundings. These lakes were very numerous to the south of the Isle of Wight and off the coasts of Norfolk and Suffolk." If the severity of the earlier period had passed away, the temperature long remained, with

Later Pleistocene geography.

* Partly represented by local deposits known as the Bure Valley beds; or, the Westleton and Mundesley beds.

seasonal variations, far below that to which we are accustomed. Glaciers still lingered in Scotland, in Wales, and in Cumberland; and it is not possible to avoid the conclusion that our rivers were much larger in volume than they are now. This is easily accounted for: the melting of the glaciers and the snow in summer would necessarily flood the streams; and if, as has been suggested, there was a heavier rainfall, the floods must at times have been very large. It is certain that the gravels of our river valleys spread out far beyond the limits of the rivers which now occupy them, and the brick earths of Erith, Crayford, and Grays, and other similar deposits in the Thames valley, suggest, if they do not demonstrate, the former occurrence of floods sufficiently formidable to sweep away and drown the larger animals of the period.

XXX.

The Declension of Adjectives—(*continued*).

VOCABULARY.

der Kaiſer, the emperor
dare ky'-zer

fromm, pious
from

der Herzog,[1] the duke
dare hairt'-tsoch

Sachſen, Saxony
zach'-sen

mächtig, mighty
mech'-tich

der Koch,[2] the cook
dare koch

der Stab,[3] the staff
dare stahb

der Stecken, the stick
dare steck'-en

der Bettler, the beggar
dare bett'-ler

der Narr,[4] the fool
dare nahrr

[resemble

gleichen (imp. glich, p. part. geglichen), to
glych'-en glich ge-glich'-en

ſtatt, anſtatt, instead of
statt, an'-statt

[speak

reden[5] (imp. redete, p. part. geredet), to
ray'-den ray'-de-te ge-ray'-det

ſchweigen (imp. ſchwieg, p. part. geſchwiegen),
shvy'-gen shveeg ge-shveeg'-en
to be silent, or keep silence

die Hauptſtadt,[6] the capital
dee howpt'-stat

[show

zeigen[7] (imp. zeigte, p. part. gezeigt), to
tsy'-gen tsyg'-te ge-tsygt'

zahlreich, numerous
tsahl'-rych

das Kunſtwerk, the work of art
dass kunst'-vairrk

berühmt,[8] celebrated, famous
be-ruemt'

die Bildergallerie, the picture gallery
dee bil'-der-gal-le-ree'

das Gebäude, the building
dass ge-boy'-de

prachtvoll, splendid
pracht'-foll

der Stein, the stone
dare styne

das Denkmal,[9] the monument
dass denk'-mahl

aufrichten, to set up, to rear
owf'-rich-ten

tapfer, valiant
tap'-fer

klug, clever
klooch

Lützener,[10] of Lützen
luet'-se-ner

die Ebene,[11] the plain
dee ay'-be-ne

die Trajans-Säule, the column of
dee trah-yahns'-zoy-le

[Trajan

errichtet, erected
er-rich'-tet

kräftig,[12] powerful
kreff'-tich

kriegeriſch, warlike
kree'-ge-rish

gewinnen (imp. gewann, past part. gewonnen), to win
ge-vin'-nen ge-vann' ge-von'-nen

friedlich,[13] peaceable
freed'-lich

gleich, alike
glych

ausgezeichnet,[14] remarkable
ows'-ge-tsych'-net

der Gedanke, the thought
dare ge-dann'-ke

klar, clear
klahr

hell, bright
hail

der Geiſt,[15] the mind, spirit
dare guyst

fähig, capable
fay'-ich

vollenden, to accomplish
foll-en'-den

der Undank,[16] ingratitude
dare un'-dank

ſchlimm, bad
shlim

das Laſter, the crime
dass lasst'-er

luſtig,[17] merry
luss'-tich

gefroren,[18] frozen
ge-froar'-en

der Fluß, the river
dare fluss

der Canal, the canal
dare ka-nahl'

die Leute,[19] the people
dee loy'-te

raſch, swift, quick
rahsh

der Schlitt-ſchuh,[20] the skate
dare shlitt'-shoe

jagen, to hunt, to rush
yah'-gen

der, die, das, letzte, the last
dare dee dass lets'te

das Mittel, the means
dass mit'-tel

die Kunſt, the art
dee kunst

viele,[21] many
feel'-e

die Küſte, the coast
dee kues'-te

treiben (imp. trieb, p. part. getrieben), to [drive
try'-ben *treeb* *ge-tree'-ben*

anſehnlich,[22] considerable
an'-zayn-lich

der Handel,[23] the trade or commerce
dare han'-del

fremd, strange, foreign
fremmd

beinahe, almost (by-near)
by-nah'-e

vergeſſen (imp. vergaß, p. part. ver-geſſen), to forget
fer-ges'-sen *fer-gass* *fer-ges'-sen*

reden (imp. redete, p. part. geredet), to [speak
ray'-den *ray'-de-te* *ge-ray'-det*

wahr, true
vahr

zahlen,[24] zahlte, gezahlt, to pay
tsah'-len tsahl'-te ge-tsahlt'

Baar,[25] cash, ready money
bahr

der Spruch, the saying
dare spruch

OBSERVATIONS.

[1] *Der Herzog*, the duke, from an old German word signifying the army leader—as duke itself is from the Latin *duco*, I lead; and *dux*, a leader.

[2] *Der Koch*, the cook; *die Köchin*, the female cook. In the same way *die Herzogin*, the duchess.

[3] *Der Stab*, like the English "staff," has various meanings. Thus we have *der Stabs-offizier*, the staff officer.

[4] *Der Thor* is used for "the fool" as well as *der Narr*, dare tore
in German; but *Thorheit* is foolishness from want of consideration, *Narrheit* from imbecility,—thus *das Narrenhaus*, the madhouse.

[5] *Sprechen*, to speak, generally; *reden*, to discourse. Thus *die Deutsche Sprache*, the German language; *eine Deutsche Rede*, a German speech or discourse.

[6] *Die Hauptstadt*, literally the head town or chief town. *Haupt* is often used in German in the sense of "chief," like "head" in English.

[7] *Zeigen* often means to point or indicate. Hence *der Zeiger*, the hand of a watch or clock; *der Zeige-finger* (tsy'-ge-fing-er), the forefinger or index finger.

[8] *Berühmt*. The prefix *be-* is often used in German, as in English, to express application to an object—as bedraggled, bepuffed, etc. "How did Grub Street re-echo the shouts that you raised, While he was be-Rosciused, and you were bepraised" (Goldsmith on Garrick).

[9] *Das Denkmal*, from *gedenken*, to remember, and *das Mal*, the sign or token, as in *Merkmal*—thus the sign of remembrance.

[10] *Lützener*. The names of towns are often converted into adjectives by the addition of *er*. Thus *die Londoner Post* (dee Lonn'-donn-er Posst), the London Post; *das Strasburger Münster* (dass strahs'-boorger muens'-ter), Strasburg cathedral (minster); *das Frankfurter Thor* (dass frank'-foort-er tore), the Frankfurt gate, etc.

[11] *Die Ebene*, from the adjective *eben*, even or flat.

[12] *Kraft*, from this the English craft, meaning originally power or skill—as in a craftsman, handicraft. After a time the word degenerated, and came to mean perverted skill, as in "craft and subtlety."

[13] *Friedlich*, from *der Friede*, peace. Thus *Friedrich* (Frederick), rich in peace.

[14] *Ausgezeichnet*, from *zeichnen*, to sign or mark (also to draw), and *aus*, out: marked out, or signed apart from the rest.

[15] *Der Geist* is also used for intellectual power generally, and intellectual power or work is called *geist-reich*. *Er gab den Geist auf*, he gave up the ghost.

[16] *Undank*, unthankfulness, like *unglück*, has no plural form.

[17] *Lustig*—hence the English lusty. "Lustily, lustily, let us sail forth" (Old sailor's song).

[18] *Gefroren* comes from *frieren*, to freeze (imp. *fror*, p. part. *gefroren*). *Mich friert* (literally "me freezeth," meaning "I am cold") is a German idiom.

[19] *Leute*, people, has no singular. It is from an old word meaning *Liuti* (Fr. *Leudes*), meaning faithful followers of a chief. Thus *Leute* is often used for attendants or servants.

[20] *Der Schlittschuh*, literally the sledge shoe (from *der Schlitten*, the sledge).

[21] *Viel* (singular), much; *viele* (plural), many.

[22] *Ansehnlich* (literally "look-at-able"), worthy to be regarded.

[23] *Handel* is used both for trade and commerce in German. The latter is sometimes called "*Seehandel*," sea-trade.

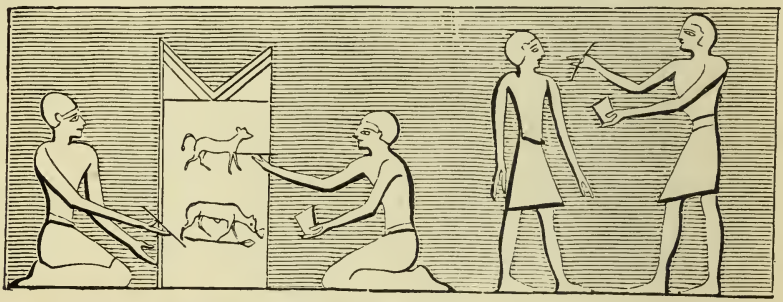
[24] *Zahlen* is like *zählen*, to count, from which we have the English "retail," to "tally," etc.

[25] *Baar* is also an adjective: *baares Geld*, ready money; *ein baarer Profit*, a cash or ready money profit.

English Version, for Correcting and Retranslating the Foregoing Study.

A quiet life is better than gold and silver. The emperor Charles the Great (Charlemagne) was a much better man than his son Louis the Pious; he also ruled longer. Henry the Lion, duke of Saxony, was the mightiest of the vassals of the German emperor; no one was greater or richer than he. "Hunger is the best cook," says the old proverb. "The heaviest staff in the land," says another proverb, "is the stick in the beggar's hand." The fool resembles the wise man most, when instead of speaking (discoursing) he is silent. Dresden is one of the most beautiful among the German capitals. No town shows greater or more numerous works of art than one finds here in the famous picture gallery. Also the churches and other buildings are most (exceedingly) splendid. Not far from a great stone which was after-

wards erected (which one afterwards erected) as a monumcnt, fell the brave, sagacious King Gustavus Adolphus, on the famous Lützen field. (The) Trajan's column at Rome was erected as a monument of the great victories which the powerful Trajan won over the warlike Dacians. After the peaceful and happy reign of Antoninus Pius, followed Marcus Aurelius, the wise philosopher, equally distinguished as (a) regent and as (a) commander. At (the) early morning the thoughts are clearest, the mind is bright, and most capable of accomplishing (to accomplish) hard work. Ingratitude is one of the worst vices. In the winter, in Holland, one sees a merry life on the frozen rivers and canals, when the people rush past on swift skates. The sword is given to the free man as a last means. Life is short, but art is long. Before many hundred years (many hundred years ago) the town (of) Stavoren, on the Dutch coast, was great and rich, and carried on (drove) a considerable trade with foreign lands; but now even the name is nearly forgotten. "Speak little, speak truth (true); use little, pay cash," is a very useful saying.



EGYPTIAN ARTISTS.

XXVI.

EGYPT (*continued*).

ARTIFICERS and dealers in articles of use and luxury made up the fourth, or "shop-keeping" class; and the fifth and lowest included herdsmen, shepherds, labourers, and other members of "the lower orders."

The art of building with polished stones, hieroglyphic writing, and considerable knowledge of the elements of physical science, appear to have been possessed by the learned class during this dynasty. The second of these Memphite kings, Serbes (the Tosorthros of the Greek lists), was an adept in the medical art, and after his death was considered as a demigod and son of the divinity Ptah. The most remarkable political event of the dynasty appears to have been a revolt of the Libyans, in the reign of Nebka (the Necherophes of the Greeks), the first monarch.

Science and art.

These Libyans, the natives of the country to the west of Egypt, a barbarous and uncultivated people, endeavoured to throw off the yoke which at some previous period had been imposed on them, but were so terrified by an eclipse of the moon that they submitted again.

The fourth dynasty, also Memphite, has bequeathed to posterity a more authentic history —the records of the monuments. The great pyramids, still wonders of the world, are memorials of the time when these kings reigned. How or why the succession to the throne was changed, we know not. The previous dynasty is supposed to have extended over 214 years—a period allowing an average of twenty-four years for the reign of each king. Dr. Birch speaks of the last seven as "inglorious monarchs," but as absolutely nothing is known about them except their names, perhaps we should do them an injustice if we adopted the epithet. The failure of the direct line, or it may have been internal dissensions, and the rise to power of some enterprising leader, are among the probable causes of the change of dynasty. The last supposition is, to some degree, supported by the fact that the first king of the new line, Senefru (the Soris of the Greek lists), seems to have been a man of enterprising and warlike character. The Sinaitic peninsula of Arabia was known as the Abt, or eastern land. The inhabitants were known as the "shepherds of the east," nomadic tribes, at that time unable to cope with the organized power of the Memphite king, but whose descendants were probably the energetic and successful invaders, the shepherd kings who, a few centuries later, made an indelible record in Egyptian annals.

The fourth dynasty.

In the Wady Magarah, the Sinaitic peninsula, that wild mountainous country the scene of the forty years' wanderings of the Israelites, is a cave, the entrance to an ancient mine; and at the entrance is a tablet, with rude sculpture and inscription, from which we learn that Senefru, the first king of the fourth dynasty, obtained a victory over some of these shepherds of the east, and discovered mines of copper and mafka (supposed to be turquoise). This is the earliest known record of Egyptian conquest.

Sinaitic inscriptions.

Senefru reigned nineteen years, and his successor Khufu was the Cheops of the Greek lists, the builder of the Great Pyramid at Gizeh.

The Great Pyramid.

How he lived we know but dimly, and the traditions preserved are not favourable, but he resolved to be buried grandly. Human labour was abundant and cheap, for it was supplied by slaves and captives, and by the wretched peasantry, whose condition was little better. The huge masses of stone required for the building of the pyramidal tomb were dragged from the quarries by thousands of men harnessed by ropes to the rudely constructed cars, and goaded by the whips of the taskmasters. If they fainted and fell, they were left to die by the wayside, and other conscripts took their places. Layer by layer the great edifice, the "mer" (for pyramid is a work of Greek origin) grew. The inner chamber, in which the embalmed body of Khufu was to be placed when the time came, was excavated, and approached by an inclined passage; and year after year additional courses of masonry, each of smaller area than the preceding, were laid, until at length the pyramid was completed—the most stupendous edifice the world has ever seen, loftier than the grandest temple raised in any succeeding age—fifty feet higher than St. Peter's at Rome. As the work progressed, the original subterranean sepulchral chamber was abandoned, and two spacious chambers, one for the queen and the other for the king, were constructed at higher levels. In the latter place the sarcophagus of the king was placed, and on the stones may still be traced in rude characters—"scrawls" they have been styled—the name of the king, Khufu; but, it is said, the sarcophagus did not contain the body of the monarch, for so intense was the popular feeling, excited by the terrible sufferings of the builders of the pyramid, that Khufu was privately interred in a subterranean chamber encircled by the waters of the Nile. Perhaps the apprehension of a popular outbreak induced the priests and nobles to conceal the fact of his death until his successor should be firmly established. The work of building the pyramid extended over thirty years, and it is estimated that seven millions of men were at different times engaged in the work of making the causeway along which the blocks of stone were dragged from the quarries, and in erecting the pyramid. They worked in what may be described as "gangs" for three months at a time, and then were relieved, those who had survived the terrible toil being permitted to return to their ordinary pursuits. All other public works, even those connected with religious rites, were suspended, the king's tomb, and that alone, being the great achievement of the reign. The causeway mentioned was 3,000 feet long, 60 feet wide, and ran through a cutting 40 feet deep. The stones of which the pyramid is constructed are huge blocks of red or Syenitic granite, varying in thickness from two to four feet. and none less than 30 feet long; and it is estimated that 85,000,000 cubic feet of stone are contained in the pyramid.

VICTORIOUS GENERAL AND CAPTIVES.

Strange theories respecting the pyramid have been recently advanced. Mr. Piazzi Smyth saw reasons for believing that it was really constructed to advance the sciences of astronomy and geography, and showed that the Egyptian philosophers of the time were acquainted with the real diameter of the earth, and had measured an arc of the meridian, and that the angle of the slope of the passage to the subterranean chamber had some connection with the observations of the polar star. Mr. James Taylor has suggested that the supposed sarcophagus was actually a standard measure of capacity, by which the measure of wheat and other commodities was to be regulated. If so, it is strange that it should have been so securely built up, and enclosed by such a mass of masonry as the world has never since seen.

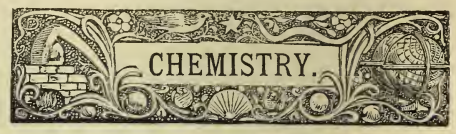
The fact seems to be that the pyramid was intended to be nothing more than a stupendous monument of the egotism of the king, and was so considered at the time and in succeeding ages. It is generally supposed that reference is made to this and the other pyramids by the writer of the Scriptural book of Job, when he refers to "princes and counsellors of the earth which built desolate places for themselves."

The Sphinx.

Tombs of members of the royal family and other great personages were erected near Khufu's pyramid, and probably the great and mysterious Sphinx was at the eastern edge of the platform on which the pyramid was built. We say probably, because some Egyptologists, among them Lepsius, have supposed that this remarkable colossal figure, which still arrests the admiration and excites the wonder of the traveller, dates from the time of Hafra, or Kephren, the successor of Khufu. Later investigation, however, has revealed an inscription which seems to establish the fact that the sphinx was in existence before the erection of the pyramid. This stupendous image, representing the body of a crouched lion with a human head, was dedicated to Hor-em-khu, the setting sun. The face is about 28 feet long, and the body has a length of 146 feet; across the shoulders the figure measures 36 feet, and the forelegs and paws are extended about 50 feet. Now the head and neck are nearly all that is visible, the drifting sands of the desert having buried the remainder of the colossal body. Strange as it may appear, the figure, except the paws, seems to have been carved out of one piece of solid stone, enormous as the dimensions are. Between the extended paws was a small temple, and close by was a vast temple, some remains of which have recently been discovered by M. Mariette. Reference appears to be made to this temple in an inscription found at Gizeh, and now in the museum at Boulak, which states that "Khufu found the temple of Isis, ruler of the pyramid, near the temple of the sphinx." The inscription also refers to an adjacent temple of Osiris, and other inscriptions mention a temple of Athor. It would appear, therefore, that the locality now known as Gizeh was a sacred spot, and that may have been the reason why Khufu desired to be buried there.

This powerful autocrat, Khufu, or Cheops, held his court at Memphis. He continued the mining operations in the Sinaitic peninsula, included in his dominions, and he appears on the tablet we have referred to as striking down an opponent, one of the natives of the country. "The Sacred Book," a work in honour of the gods, is ascribed to him; and there is a record of an offering by him of images of gold, stone, ivory, bronze, and ebony to the gods.

Khufu was succeeded on the throne by Shafra, who built the second pyramid, and a temple near the sphinx, adorning it with statues of himself in green basalt. The wife of Shafra was Merisankh, a priestess of Thoth, thought by some to have been the daughter of Khufu. We have no record of any remarkable public events in this reign.



XXVII.

AMMONIUM.

Ammonium a quasi metal.

THE compound known as ammonium, of whose constitution and attributes we have already spoken, finds a place among the alkaline metals. It will be remembered that ammonia, whose formula is NH_3, is a pungent gas having a powerfully alkaline reaction, and being very soluble in water. In the highly important series of the ammoniacal salts the base or metallic constituent of the salt was held to be the substance ammonium, which, although a compound, behaved like a metal. This compound, whose hypothetical existence in the ammoniacal salts was thus recognised, is no doubt very unstable: were it possible to isolate it, however, we may assume that it would present such characteristics as to show that it possessed not merely the theoretical attributes but the actual appearance of a metal. It further asserts its claim to be considered as such by uniting indirectly with mercury to form an amalgam—a compound, however, which is exceedingly unstable, being quickly resolved into ammonia, hydrogen, and mercury.

Base of ammoniacal salts.

Assumed appearance of ammonium.

Forms an amalgam with mercury.

Salts of ammonia.

Of the salts of ammonia the following are some of the most important. Ammonium chloride, or sal-ammoniac, is an analogue of potassium and sodium chloride, whose formula is $(NH_4)Cl$, and which is generally prepared, in the present day, from the ammoniacal liquor of gas-works. Ammonium carbonate $(NH_4)_2CO_3$ is a very unstable compound, which decomposes on contact with air with evolution of ammonia. Ammonium nitrate is, it will be perceived, an analogue of nitre, whose formula is $(NH_4)NO_3$. The other principal salts of this series are the phosphates, the sulphates, the sulphides, etc. The whole of the salts of ammonia may be recognized by their giving off an alkaline gas, having the characteristic smell of ammonia, when heated with caustic lime or caustic potash.

Characteristic of these salts.

HYDROXYLAMINE.

Hydroxylamine.

This term is applied to a compound which unites with many of the acids like a base to form a series of salts. It may be regarded as ammonia, NH_3, in which an atom of H is replaced by the hypothetical compound OH, known as hydroxyl: thus, $NH_2(OH)$ or NH_3O. Hydroxylamine has not been isolated, but it can be shown to exist in an aqueous solution, to which it imparts a powerful alkaline reaction.

The six metals we have just enumerated belong to the alkaline series; we now come to those of the alkaline earths, the first of which is that known as

Metals of the alkaline earths.

CALCIUM,

or the metal of lime; the latter substance being an oxide of the metal calcium. This element, combined with others, forms a large portion of many important geological formations, such as chalk-limestone, lias, mountain-limestone, etc. Neither the metal itself, however, nor its oxide, is ever met with native or uncombined. The metal, which is obtained by the decomposition of its chloride by electric action, is of a light yellow colour, and oxidizes readily on exposure to air. Lime, the oxide of this metal, has a strong tendency to unite with carbonic acid whenever it is brought into contact with it, forming chalk or limestone. Hence the use of lime as a disinfectant. The affinity of this substance for carbonic acid may be illustrated by the simple experiment, already described, of blowing into a glass of lime-water, when the carbonic acid present in the breath, uniting with the lime, renders the solution turbid by the formation of chalk. Lime is obtained by burning chalk or limestone in a kiln, and driving off the carbonic acid in the form of a gas, by the agency of heat. Lime burning has been practised from a very remote antiquity, and the term "fixed air" was formerly applied to carbonic acid, from the fact of it being thus bound up with the substance of certain rocks. The quicklime, or caustic lime, thus obtained, in such universal use for building purposes, is too well known to require a special description. It is an infusible substance, having a strong affinity for water. When water is poured on quicklime, chemical action is at once set up, great heat is evolved, and the result is the formation of a compound, commonly called slaked lime—calcium hydroxide or hydrate of lime—a white mealy substance, much softer to the touch than lime, and partially soluble in water. Mortar is made by the admixture of the hydrate with a due proportion of silica in the form of sand, the whole worked up to a proper consistence by the addition of water. The hardening or setting of mortar or plaster, made from lime, is due firstly to the absorption of carbonic acid from the atmosphere, and secondly to a gradual combination of the silica with the lime. A mortar which is not acted upon by water, and can therefore be used for submarine structures, is formed from limestone containing a considerable portion of clay and silica. A combination of the silicate of lime with the alumina (clay) appears to give to this mortar its hydraulic or water-resisting character. The

The metal of lime.

Metallic calcium.

Tendency of lime to combine with carbonic acid.

Lime burning.

Quicklime, its affinity for water.

Slaked lime—a hydrate.

Silica in mortar.

Hardening of mortar.

Hydraulic mortar.

uses of lime in agriculture are well known; it not only checks the superabundance of useless vegetal growth, but, by decomposing the silicate of potash, in heavy soils, sets free the latter substance, whose functions in connection with vegetation are so important.

Uses of lime in agriculture.

Calcium Carbonate,

or carbonate of lime, as it is commonly termed, is of very common occurrence, forming no inconsiderable portion of the crust of our planet, rising in many places into lofty ranges of mountains, and existing in the various forms of chalk, limestone, marble, etc. This substance likewise enters into many organic structures, as the shells of crustaceans and molluscs, and the bones of animals. It is likewise the principal constituent of those wondrous structures known as coral reefs and coral islands. Many of the rocks of the limestone series consist, indeed, almost entirely of the remains of organic structures. The well-known double refracting or Iceland spar is one of the forms in which this salt crystallizes. Calcium carbonate, as already stated, is almost insoluble in pure water, but dissolves readily in water containing carbonic acid. As most waters hold a greater or less quantity of this gas in solution, it follows that the generality of natural waters contain this salt, which imparts to them the quality of hardness, as it is termed. Such water, when boiled, deposits a coating or crust of carbonate of lime on the sides of the kettle or boiler containing it. This result is due to the expulsion of the carbonic acid by boiling. Hard water may be rendered soft by the addition of a certain quantity of powdered lime, which, uniting with the carbonic acid, renders the water incapable of holding chalk or limestone in solution.

Carbonate of lime.

Found in organic structures.

Its crystalline form.

Cause of hardness in water.

Fur in kettles.

Means of rendering hard water soft.

The formula of calcium carbonate is $CaCO_3$—that is to say calcium oxide or lime united to carbonic acid, or the metal calcium replacing the hydrogen of the hypothetical acid. The formula of another important salt of lime, the sulphate, is of course $CaSO_4$. This substance occurs naturally in the form of a mineral called anhydrite, and combined with water in the forms of gypsum or alabaster, and crystalline as selenite. Water holding this salt in solution cannot be rendered soft by boiling. Gypsum, when heated, loses its water and falls into a white powder known as plaster of Paris, useful as a cement and also for taking casts and moulds. Calcium chloride is a soluble salt formed when limestone is dissolved in hydrochloric acid. Bleaching powder, or chloride of lime, is a mixture of this salt with calcium hypochlorite. Its bleaching action is due to its partial decomposition, attended by the liberation of oxygen. Of calcium fluoride or fluor spar we have already spoken, under the

Gypsum.

Plaster of Paris.

Bleaching powder.

head of fluorine. It is found crystallised in cubes of a blue-green colour in certain mountainous districts. It is commonly known in this country by the name of Derbyshire spar. In enumerating the salts of calcium, we must not forget to mention calcium phosphate or phosphate of lime. This is the principal earthy constituent of the bones of mammals, which owe much of their hardness and rigidity to its presence. If a bone be calcined or burnt, the white incombustible portion that remains behind will be found to consist chiefly of this salt.

Fluor spar.

Phosphate of lime or bone earth.

The other two metals of the alkaline earths are barium and strontium, neither of them being anything like so widely diffused or so important as calcium. The two most common compounds of barium are the carbonite or witherite, and the sulphate or heavy spar. The metal barium greatly resembles calcium in its principal attributes. The monoxide of barium is known as baryta, a grey porous mass, fusing at a high temperature. Like calcium oxide, it unites with water with the evolution of heat, forming a crystalline hydrate. A solution of this substance, perfectly transparent in appearance, absorbs carbonic acid from the atmosphere, and if any large proportion of that gas be present soon becomes turbid or milky. A solution of baryta is therefore a valuable test of the purity of the air. Barium sulphide is used in the laboratory as a precipitant for sulphuric acid, while the sulphate, to which the name of heavy spar is given on account of its weight, is met with in a state of nature in a crystalline form. A precipitate of this salt, in the form of a white powder, is used as a pigment. White lead is not unfrequently adulterated with this substance.

Barium.

Baryta.

A test of the presence of carbonic acid.

Heavy spar.

FIG. 173.—DICLINOUS FLOWERS OF HAZEL.

Strontium occurs in smaller quantities than barium. Two of its best known compounds, met with native, are the carbonate, strontianite; and celestine, as it is termed, the sulphate. The metal strontium, when isolated, somewhat resembles calcium in appearance. The oxide of strontium, strontia, is generally obtained by decomposing its nitrate. Like oxide of calcium, it unites with water, evolving great heat, and forming the hydrate, which is soluble in water and absorbs carbonic acid with avidity. The native salts of strontium, the carbonate and the sulphate, are insoluble in water. From them the other salts may be prepared. The nitrate and the chloride are soluble in water, and are employed in making fireworks and in the preparation of red fire for scenic effects on the stage, as they impart a rich crimson glow to the flame. Strontium is met with, in minute quantities, in the waters of certain springs.

Strontium.

Strontia.

Native salts of strontium.

Red fire.

The next class of metals we have to consider are the so-called metals of the earths. The only one of these to which we propose to direct attention is aluminum or aluminium; the other metals of the series, such as yttrium, erbium, etc., occur very rarely, and not being employed for any useful purpose, we shall not speak of them further.

Metals of the earths.

BOTANY.

XXIX.

CLASSIFICATION OF PLANTS (*continued*).

THE Linnæan system, though now almost entirely superseded by the "Natural," or that which distributes plants into "families," is so valuable and interesting that any sketch of Botany would be incomplete that did not notice it as to its details. It is worth observing, too, that the only book in the English language which deals with plants of every kind, and gives descriptions of the species, is constructed upon the Linnæan system. This is Loudon's Encyclopædia, originally published in 1827, and in later years enlarged by the addition of a first and second supplement, the latter bringing it up to 1855. Doubtless, since the latter year, many hundreds of new plants have been introduced from foreign countries with which Loudon and his successor, Mr. Don, were unacquainted; but of these there is no dictionary whatever, whereas Loudon gives a key to everything of importance known up to the year mentioned, 1827. The contriver of this wonderful system began, as said above, with the stamens and pistils, and finding that in vast multitudes of plants the numbers of these parts are fairly constant, he at once established ten classes, the members of which should be told by simple counting. The stamens being the male organs of the flower, and a form of the Greek word for "a man" being easily convertible into the termination *andria*, there was nothing more to do but to prefix the numerals. Hence we have, as the names and characters of the first ten Linnæan classes, the following:—

The Linnæan system.

1. Monandria . . One stamen.
2. Diandria . . Two stamens.
3. Triandria . . Three stamens.
4. Tetrandria . . Four stamens.
5. Pentandria . . Five stamens.
6. Hexandria . . Six stamens.
7. Heptandria . . Seven stamens.
8. Octandria . . Eight stamens
9. Enneandria . . Nine stamens.
10. Decandria . . Ten stamens.

Whether free, or perigynous, on the calyx or corolla, is by this mode of arrangement immaterial. Nor is it asked, are the plants in any way related? The result of course is that every one of the classes is immensely heterogeneous. The point is gained nevertheless,—a place for everything, and everything in its place.

The number eleven scarcely occurs in Botany. The only genus in which it appears to be normal is *Cuphea*, one confined to America, and of a family which is inclined to be characterized by ten or twelve. There was no need, accordingly, of a class for plants with *eleven* stamens; and the eleventh, actually, is composed of twelve-stamened ones, with the appropriate name of Dodecandria. The two next, or thirteenth and fourteenth, consist of plants with numerous stamens, say from twenty to two or three hundred. These are called respectively Icosandria and Polyandria, the former comprising the perigynous and the latter the hypogynous. Then we have two ingenious classes which nearly correspond as to limits with the great natural orders Labiatæ, Scrofulariaceæ, and their allies, and the Cruciferæ, the fourteenth called Didynamia, and the fifteenth, Tetradynamia. The sixteenth, seventeenth, and eighteenth classes also bring many nearly related plants into close neighbourhood, the characters here depending on those curious adhesions of the filaments of the stamens above described, when treating of the general structure of the flower, and which are happily designated by the term *adelphia*, literally "brotherhood." They are called Monadelphia, Diadelphia, Polyadelphia. The nineteenth class, Syngenesia, corresponds absolutely with the Daisy family, or the Compound flowers, in which the anthers are united. The twentieth, Gynandria, corresponds, almost exactly, with the orchis family. Then come three classes constituted of the Unisexual plants —Monœcia, Dicœcia, and Polygamia. Nothing exists in nature that does not fall easily, as regards the marks supplied by the flowers, into one or other of these twenty-three great companies, miscellaneous it is true, but unmistakable; and in the last place, the twenty-fourth class, covering every possibility among the non-flowering plants, is called Cryptogamia. No wonder that a system so simple, so compact, so intelligible, at once took root, and rendered the life which previously to the time of Linnæus was burdened and beset with difficulties, once again joyous and progressive.

FIG. 174.

In considering the Linnæan system, it is important to observe the different meaning attached at the present day to the phrase "Natural order," and that which the simple word "order" denoted, and still denotes, in the celebrated scheme of classification we have just described. Linnæus subdivided the first thirteen of his great groups, on the same general principle as that upon which they were formed. The pistils (the female portion of the floral apparatus) being equal in importance to the stamens, and also varying in number, in different plants, from one to a hundred or more, nothing was readier or more helpful in proceeding with the analysis. The Greek word for a woman, as said above, is *gynë*, and this being shaped into *gynia*, at once furnished names for the sub-classes, or Linnæan "orders," Monogynia, Digynia, and so onwards, up to Polygynia. The great majority of flowers have only one pistil, though, as described above, this apparently one is in reality formed by the confluence and cohesion of two, three, four, or five. But it is solitary, for all practical purposes. Hence the first "order" in the various classes, Monogynia, is always by far the largest, the only near approach to it being Digynia, in the fifth class, which is constituted almost exclusively of the Parsley family. The "orders" of the subsequent Linnæan classes are formed in different ways, but in every case they are exquisitely ingenious, and in many instances declare the contriver's accurate perception of natural relationships.

The Linnæan "orders."

Linnæus designed his wonderful artificial or sexual system merely as an expedient to facilitate the progress of Botany, while its great ultimate object, so far as regards classification, was still in the dim future. He recognized all the great natural families which had been determined by his predecessors; and gave his own mind, during the remainder of his useful life, to inquiry for the others. Adopting all he found that was good and exact, he superadded an immense amount of new observation, and in reality laid the foundations of the splendid system, which having been completed as to essentials by the great botanist Jussieu, was for many years known as the Jussieuean, but is now termed the "Natural." All such discoveries are progressive. We rarely or never see the actual beginning of anything, and the first steps in the Natural system may quite as justly be attributed to the fine old inquisitive and ardent observers of the sixteenth century.

The Natural system.

Jussieu was a Frenchman. Living at a time when his country was distracted by revolution and warfare, his work supplies a very interesting illustration of the independence of philosophy. Men may quarrel, and slay one another, burn and destroy their neighbours' homes, and induce misery of a thousand kinds, but philosophy, like the trees, goes on growing, calmly and consistently. So that, early in the present century, the world found itself rich in the possession of a comparatively new and very beautiful and inviting system of Botany,—one which could be pursued contemporaneously with the use of the Linnæan,—the latter serving all the immediate needs of the classifier, the former the joy of the scientific. Jussieu had established exactly a hundred families. Many of them were tentative, and perhaps little more than conjectural. Still they were all shaped upon sound principles, and now it remained only to work out the details, expanding and correcting. Robert Brown, in our own country, the younger Jussieu, the De Candolles of Geneva, father and son, many renowned German botanists, Endlicher among the foremost, and, by degrees, a long train of diligent students, including Dr. Lindley, assisted in the good work, and to-day it is strenuously furthered by Mr. Bentham, Sir J. D. Hooker, and all the leading botanists of Europe and the United States. No one must suppose that the Natural system even yet approaches the perfection which is doubtless attainable all in due time. It is only the artificial that can be rounded off and pronounced complete. Anything proposing to be a reflex or interpretation of nature, or of any considerable portion of it, must needs be of slow growth. Not until every particular concerning the structure and the life-history of every plant in the world is known, minutely and accurately, will the marshalling of the whole, in a way that shall seem unobjectionable, be at the command of botanical science; and even then there will be the great and permanent difficulty of the varying composition of the human mind, and the different estimate sure to be placed upon the anomalous. The profoundest and most comprehensive botanical work of modern times—the "Genera Plantarum" of Hooker and Bentham—contains numbers of instances wherein even these two learned men have been unable to decide positively;—at the end of the list of the genera referred to a given family or Natural order, every now and then comes a little appendix of something in delicate particulars paradoxical.

Jussieu and his followers.

Very interesting is it also to observe that while botanists, as a whole, are fairly agreed as to all the principal families, there is wide divergence of opinion as to the sequence in which they should follow. It is like attempting to catalogue the books in a great library. The historian, the artist, the naturalist the moralist, the mechanician, the geographer, the poet, the lover of fiction, take each of them a different view of the importance of the various writings, and of the places of respective honour and inferiority. Two principal methods of arranging the families are in use, each possessing its own merits and advantages, and which of them is best to adopt is really very much a matter of taste and opinion. Both start with the grand distinction, inevitable at the outset, which establishes the Phænogamia and the Cryptogamia. Both also are pretty well agreed as to the definition and the boundaries of the Exogens and Endogens. The difficult step is the one to take next; and here we are at once launched upon the contrast between the plan proposed by Jussieu and enlarged by De Candolle, and that one which, having had for its chief priest in this country the late Dr. Lindley, may be fittingly termed the Lindleyan. Not that Lindley was the parent, but it was he who gave it prominence, and perhaps it is but fair to say, completeness.

The primary divisions.

Taking in the first place the families of the exogens, by the Candollean system, they are primarily resolved into Dichlamydeæ, or plants with flowers having both calyx and corolla; Monochlamydeæ, or those which have calyx only; and Achlamydeæ, or those which have no proper floral envelopes, the stamens and pistils being protected only by bracts, or in some cases quite naked.

De Candolle's system.

The Dichlamydeous families are distributed, in turn, into three great subsections,—those with hypogynous stamens, called Thalamifloræ; those with the stamens upon the calyx, and the petals free, called Calycifloræ; and those with united petals and epipetalous stamens, called Corollifloræ. The monochlamyds and the achlamyds do not require sub-sections; and the endogens may be said to speak for themselves, falling quite naturally and obviously into the sections called Petaloideæ, having their type in the lily; Glumiferæ, or grasses and sedges; and Spadicifloræ, which have their inflorescence in the form of a spadix, more or less perfectly developed, and while young enclosed in a spathe. This method is no doubt ingenious and praiseworthy in the highest degree; but it ignores particulars of greater importance than those which it recognizes, and is open to the still more serious objection of mixing up unisexual plants with bisexual ones. Had it not obtained a firm hold in this country before the promulgation of the Lindleyan, the latter would in all likelihood have received a more general suffrage. As it is, the Candollean system is followed in nearly all the Floras and popular text-books, and is now more likely than ever to hold its ground, being abided by in the "Genera Plantarum."

Lindley's writings.

By Lindley, pre-eminently in the "Vegetable Kingdom," a book grounded largely upon German authors, the exogens are first separated into monoclinous and diclinous. This is very good, because recognizing a high principle in the structure of plants,—one which will some day be recognized as far before and above differences in the floral envelopes. If the distinction of male and female were never more marked than in the Lychnis dioica,

there might be ground for denying its value; but when we observe that in the Amentiferæ, the Euphorbiaceæ, the Coniferæ, and many other families, there is a concurrent difference in the entire structure of the two sexes of flowers, it is plainly one deserving to be viewed with the utmost care. In the Candollean system, as said above, monoclines and diclines have no separate places, except such as follow upon the mere accidents of perianth. The monoclines are next divided, in Lindley, according to the position of the ovary. First come the hypogynous exogens, in which it is free within the perianth, the stamens also free. Next we have the perigynous exogens, in which again the ovary is free, but the stamens are seated either upon the calyx or the corolla. Thirdly, we have the new great section, not admitted into the Candollean system, which consists of plants with uniformly epigynous stamens. The stamens and the ovary being the vital parts of the flower, it stands to reason that they should be more valuable in matters of classification than the non-essential calyx and corolla, so often absent, more or less, whereas the stamens and the ovary are indispensable.

XXIV.

NUMERALS (*continued*).

3. Numeral adverbs are formed by adding *ment* to the feminine of the ordinal numeral :

1stly = premièrement 3rdly = troisièmement
2ndly = secondement 4thly = quatrièmement

One says also : *en premier lieu, en second lieu, en troisième lieu,* etc. *Primo, secundo* (r. *sékondo*), *tertio,* are reckoned as French adverbs ; not so the forms which in Latin naturally follow *tertio.*

4. A few hints on numbers used in colloquial French with reference to time, age, cards, weights and measures.

a. When asking the time of day say :

quelle heure est-il ? *what hour is it ?*
il est une heure, *it is one o'clock.*
il est deux heures, *it is two o'clock.*
il est midi, *it is twelve, noon.*
il est minuit, *it is twelve, midnight.*

Never say *il est douze heures.* The question *quelle heure est-ce ?* would only be used if, pointing to the clock, or hearing the clock strike, you were asking *what o'clock is this?* The answer to that question would be *c'est une heure, c'est deux heures,* etc. For fractions of hours begin with the *full* hour, and for *past* use *et,* for *to* use *moins :*

5 *minutes past* 3 = trois heures et cinq minutes.
a quarter past 7 = sept heures et quart.
half-past 11 = onze heures et demie.
half-past 12 = midi et demi.
25 *minutes to* 8 = huit heures moins 25 minutes.
a quarter to 9 = neuf heures moins le quart.
5 *minutes to* 10 = dix heures moins 5 minutes.

For my watch is five minutes fast, say *ma montre avance de cinq minutes ;* the timepiece is ten minutes slow = *la pendule retarde de dix minutes ;* by how much are you fast, slow ? *de combien avancez-vous, retardez-vous ?* by five minutes = *de cinq minutes.*

b. When inquiring for the age say : *quel âge avez-vous ?* what age have you ? and use *avoir* in the answer : *j'ai vingt ans.* I am twenty. The number is never used absolutely, as in English : *il est mort à l'âge de soixante ans,* he died at the age of sixty. One says also, *il est âgé de seize ans,* he is sixteen years old ; *elle était âgée de soixante-quinze ans lorsqu'elle mourut,* she was seventy-five when she died. How old should you say she was ? = *quel âge lui donneriez-vous ?*

c. The names of the suits in cards are : *cœur,* hearts ; *carreau,* diamonds ; *pique,* spades ; *trèfle,* clubs. Whether speaking of court cards or common cards, use the singular :

le roi de cœur,	*the king of hearts ;*
la dame de carreau,	*the queen of diamonds ;*
l'as de pique,	*the ace of spades ;*
le valet de trèfle,	*the knave of clubs ;*
le dix de cœur,	*the ten of hearts, etc.*

Translate What is trumps ? spades are trumps, by *de quoi est la triomphe ? la triomphe est de pique.* I play trumps = *je joue en atout ;* how many trumps have you ? = *combien d'atouts avez-vous ?*

d. Without entering on an exposition of the French system of weights and measures, we would submit one point to the attention of learners. Simple as the system is, one is apt to get confused with the nomenclature of multiples and subdivisions. The memory will be much relieved if it will take hold of this simple fact—viz., that all multiples bear GREEK names : *déca* (10), *hecto* (100), *kilo* (1000), *myria* (10,000) ; and that all subdivisions are called by the LATIN forms *déci* (·1), *centi* (·01) *milli* (·001). Therefore, *hectomètre, hectogramme, hectolitre,* can only mean 100 *mètres,* 100 *grammes,* or 100 *litres* ; and *centimètre, centigramme, centilitre* mean the hundredth part of a *mètre, gramme,* or *litre.*

Practical Application.

1. VOCABULARY XIV.

(*A sequel to Vocabulary XIII.*)

Le temps et ses divisions, *Time and its divisions :—*

le jour de l'an	*New-year's-day.*
le jour des Rois	*Twelfth-day, or Epiphany.*
le carnaval	*carnival.*
le mardi gras	*Shrove-Tuesday.*
le mercredi des Cendres	*Ash-Wednesday.*
le carême	*Lent.*
la mi-carême	*Mid-Lent, 3rd Thursday.*
le dimanche des Rameaux	*Palm-Sunday.*
la semaine sainte	*Passion-week.*
le jeudi saint	*Maundy-Thursday.*
le vendredi saint	*Good Friday.*
Pâques, *m.*	*Easter.*
l'Ascension, *f.*	*Ascension-day.*
la Pentecôte	*Whitsuntide.*

la Fête-Dieu	*Corpus-Christi-day.*
La Toussaint	*All-Saints-day.*
l'Avent, *m.*	*Advent.*
la veille de Noël	*Christmas-eve.*
Noël, *m.*	*Christmas.*
l'anniversaire, *m.*	*the anniversary.*
le jour de naissance	*the birthday.*
la fête d'une personne	*a person's patron saint's day.*
la fête patronale	*the annual holiday, the patron saint's day of a place.*
les fêtes mobiles	*movable feasts.*
un jour de fête, un congé	*a holiday.*
les vacances, les congés	*the holidays.*
la veille	*the eve.*
l'aube, l'aurore, *f.*	*dawn*
le point du jour	*the break of day.*
le matin	*the morning.*
le soir	*the evening.*
le crépuscle	*the twilight.*
la nuit	*the night.*
le lever du soleil	*sunrise.*
le coucher du soleil	*sunset.*

2. Revise *parler* and conjugate after it:

passer, *to reside*	toucher, *to touch*
chercher, *to look for*	arriver, *to arrive*
admirer, *to admire*	résider, *to reside*
trouver, *to find*	donner, *to give*
traiter, *to handle*	jouer, *to play.*

EXERCISE XXXV.

1. Catherine deux, impératrice de toutes les Russies, a été l'un des premiers auteurs du partage (*partition*) de la Pologne; Frédéric deux, roi de Prusse, et Marie-Thérèse d'Autriche ont été les deux autres (*other two*). 2. La raison tient (*partakes of the nature of*) de la vérité, elle est une: l'on n'y arrive que par (*you reach it by . . . only*) un chemin, et l'on s'en écarte (*one wanders away from it*) par mille (*La Bruyère*). 3. Le vingt-cinquième anniversaire d'un mariage s'appelle quelquefois (*is sometimes called*) les noces (*nuptials, marriage*) d'argent, la cinquantaine s'appelle les noces d'or; on parle aussi de noces de diamant (*diamond*) celles-ci (*these, this*) ont lieu (see p. 232) dix ans après les noces d'or. 4. La quarantaine rigoureuse (*strict*) est de quarante jours. 5. En parlant des choses qu'on achète (*of things that one buys*) on dit (*one says*) un CENT de *fagots, d'œufs, de prunes, de pommes*, etc.; par contre (*contrariwise*) on dit une CENTAINE d'hommes, de chevaux, d'ouvriers, etc. 6. Malesherbes périt sur l'échafaud révolutionnaire, le vingt-deux avril mil sept cent quatre-vingt-quatorze, âgé de soixante-treize ans. Un monument a été élevé en mil huit cent-dix-neuf, dans la grande salle (*hall*) du Palais de Justice, de Paris, à la mémoire de ce noble magistrat; il porte (*it bears*) une inscription latine que l'on attribue (*which is attributed*) au roi Louis dix-huit.

IV.

FRICTIONAL ELECTRICITY (*continued*).

NUMEROUS other experiments, besides those mentioned in our preceding article, may be devised to illustrate the facts and phenomena of induction, and many will no doubt suggest themselves to the ingenious student. We may, however, mention the following. Balance a lath upon an egg, or in some other way, so that it is free to rotate horizontally about its centre, and place under one end of it a gold-leaf electroscope. Now bring near the other end an excited stick of sealing-wax, and cause the lath to rotate as in our first experiment; it will be found that every time the lath passes over the electroscope, the gold leaves of the latter will diverge with negative electricity.

Further experiments to illustrate induction.

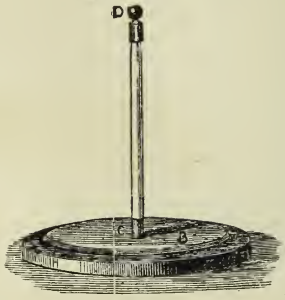


FIG. 10.

Another amusing experiment is the following. To one end of your insulated cylindrical conductor fasten a short piece of stout wire, and so place the conductor that this wire is just immediately over a gas-burner, which has the gas turned on but not lit. Now get a piece of thoroughly dry cardboard, and after rubbing it briskly with caoutchouc, bring it near the end of the conductor which is opposite to that which has the wire fixed to it: a spark will pass from the wire to the burner and ignite the gas. Turn out the gas and remove the card, a second spark will probably pass between the wire and the burner and re-light the gas.

An amusing experiment.

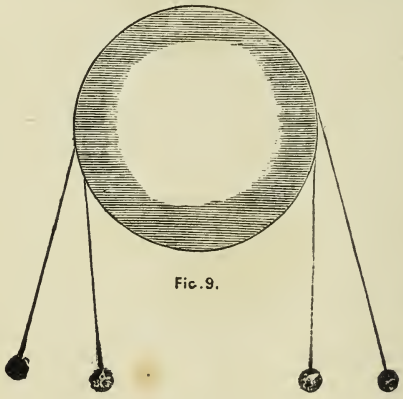


FIG. 11.

In this latter case the positively electrified card repels to the further extremity of the cylinder its positive electricity, while the negative is attracted towards the end nearest the card. The positive electricity, thus repelled, passes to the earth, negative electricity from the latter passing to the wire, and the union of the two electricities results in a spark which lights the gas.

Explanation of foregoing experiment.

On the other hand, when the card is withdrawn, the negative electricity of the conductor

being now free escapes to the earth, while positive passes from the earth to the cylinder, until the two electricities neutralize each other and the conductor resumes its normal condition, the interchange of the two electricities resulting as before in a spark which may re-light the gas.

Having now some notion of what induced electricity is, we may proceed to consider a very important though simple piece of apparatus which depends for its efficiency upon the principle of induction.

A cheap electrophoros.

Borrow Baby's tin plate, or buy one for a penny at the toy shop. Procure also a stick of sealing-wax, and either a small sheet of vulcanite or a piece of brown paper. Warm the plate over a candle, and fix the sealing-wax vertically to its centre, so that it shall form an insulating handle. Next excite your vulcanite or brown paper in the usual manner, and place the tin plate upon it. Now touch the plate for an instant with your finger, and then raise it by the insulating handle. Upon bringing the knuckle of the other hand near the plate a small spark will result, and several sparks in succession may be obtained by simply repeating the process without re-exciting the vulcanite or brown paper.

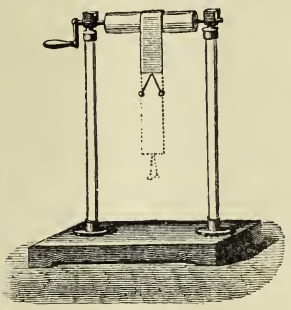


FIG. 12.

This simple apparatus is a rough form of *electrophoros* (Gr. *elektron* amber—from whence *electricity*—*phoreo*, I bear). The principle of its action is as follows.

Principle of the electrophoros.

The upper surface of the vulcanite or brown paper is negatively electrified, and when the tin plate is placed upon it its electricity is decomposed, positive being attracted and negative repelled. The latter is therefore said to be "free," while the former is "fixed." But very little actual interchange of electricity takes place between the plate and the vulcanite, as the two surfaces only touch one another at a few points, and the vulcanite, being a bad conductor, does not permit these isolated points to become recharged. When the plate is placed upon the vulcanite, part of the positive electricity from the bottom of the latter passes to the earth, and negative passes from the earth to the vulcanite. When the hand is brought into contact with the plate, its free negative electricity escapes, and positive is left behind; so that when the plate is raised and the hand again brought near it, a spark—due to the recombination of the two electricities, positive from the plate and negative from the hand—results. When the plate is withdrawn from the vulcanite, positive electricity again accumulates upon the bottom of the latter and negative upon the top; and if the plate be again placed upon it, and be touched with the finger as before and again lifted, a second spark may be obtained; and the same process being repeated, several sparks in succession may be obtained from the plate without re-exciting the vulcanite.

FIG. 13.

Such is the principle of the electrophoros, and our readers will no doubt be anxious to make a more effective one than the simple form which we have just described. Such an one is shown in our diagram (fig. 10).

A better form of electrophoros.

Into a shallow metal dish, or a wooden one lined with tin-foil, is poured, while warm, a mixture of gum-mastic, shell-lac, marine glue, and Venice turpentine, in the proportion of five parts each of gum-mastic and shell-lac to two of Venice turpentine and one of marine glue. This mixture is allowed to cool and harden, and is the so-called "cake" of the electrophoros, the dish into which it is poured being the "form." Air bubbles must be got rid of, and the best way to do this is to pass a gas-burner over the cake as it hardens, which will burst the bubbles. The next important part of the apparatus is the plate B, which should consist of a circular brass disc with an insulating handle, D, of varnished glass, which latter may be made to fit into a socket on the upper side of the plate. At one portion of the plate a small piece of stout wire with a knob attached, and bent in the fashion of an S, should be soldered. Our electrophoros is now complete, and its principle and mode of action is precisely that given above in the description of the more simple and inexpensive form of the apparatus. The knob is the point of the plate from which the sparks can be most conveniently obtained.

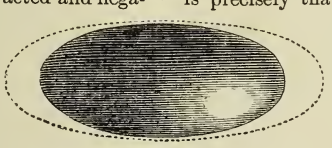


FIG. 14.

The next important feature connected with frictional electricity is the manner in which it disposes itself over the bodies of substances which are electrified.

Distribution of electricity.

In order to illustrate this portion of our subject, it will be necessary to construct one more piece of simple apparatus. This is a conical conductor; it may be made either of metal, or of wood covered with tin-foil or gilt paper; or it may be made simply of a piece of cardboard bent into the shape of a cone, and covered with metallic paper.

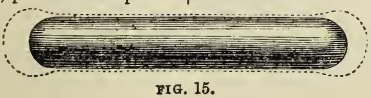


FIG. 15.

Whatever may be the material of which it is constructed, it will be advisable to make the base of the cone of such a size that it will easily fit into the end of the hollow conducting cylinder already constructed. If now we place

a ball at one end of our conducting cylinder, and the cone at the other, we shall have a conductor having one end rounded and the other conical. Having fitted up this irregularly-shaped body, insulate it, either by placing it upon an insulated stand, or by suspending it with silk dipped in melted paraffin. There should also be suspended from it two pairs of pith balls hung by cotton, one pair from the rounded extremity, and the other *near* the pointed end of the conductor.

Now give to the conductor a charge of electricity—which may of course be done in the same way that an electroscope is charged; it will be found that while the pith balls at the rounded end of the conductor diverge but slightly, those near the pointed end suffer a very considerable amount of divergence. Again take your metal ball, and suspend from it two pairs of pith balls in the manner shown in fig. 11.

Experimental illustrations.

Now insulate it, and give it a charge of electricity; it will be found that both pairs of balls diverge, and that the amount of their divergence will be equal.

What then do these experiments tell us? Obviously, that in our irregularly shaped conductor the electricity is more evident at the pointed extremity than at the rounded one; while in the second case our experiment shows us that the electricity of a sphere is equally spread over its whole surface. Careful investigation has shown this invariably to be the case, and if we imagine an atmosphere or ocean of electricity to surround electrified bodies, the "tension" of that electricity on differently-shaped conductors may be represented as in our diagrams (figs. 13, 14, 15), the distance between the dotted lines and the outline of the figures representing the depth of this hypothetical ocean or atmosphere, or in other words the "tension" of the electricity, it being of course thoroughly understood that no such atmosphere or ocean is known to exist, but its existence is merely *supposed* for the purpose of assisting the graphic representation of the facts.

Meaning of foregoing experiments.

By our diagrams it will be seen that on a cylinder the tension of the electricity is greatest at its two ends, and the same is seen to be the case with an oval body; and if either of the ends of the latter be drawn out to a point, the tension or tendency to separate from itself becomes so great that the electricity no longer remains upon the conductor, but escapes into the atmosphere.

If a flat plate be electrified, the density or tension of electricity upon its surface is greatest at the edges. When the tension of the electricity upon any body is sufficiently great to cause it to discharge into the air, the latter becomes electrified, and its particles being mutually repellent, give rise to what is known as an "electric wind." This electric wind may be excited at opposite points of a light body, and by this means it may be made to float in stable equilibrium in the air, to the great astonishment of the uninitiated. The experiment is also interesting, as it proves the possibility of the particles of the air assuming the electric state.

III.

MOTION (*continued*).

§ 10. In the last two sections we assumed that the body whose motion we were considering moved with the same velocity throughout; but this is not generally the case; in almost all instances of motion the body changes its velocity; it sometimes moves faster, and sometimes more slowly. A train, for instance, on

Varying velocity.

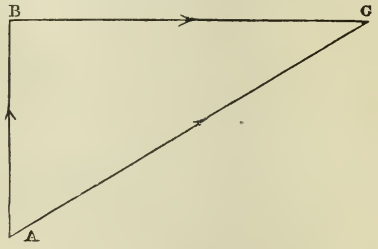


FIG. 4.

leaving a station moves slowly; its velocity increases until the "full speed" is attained; then it gets sometimes less and sometimes greater (in going up or down an incline, for example); afterwards the velocity is gradually decreased until the train once more comes to rest. Here we have a good case of changeable velocity. The question is at once suggested,—What is meant by the "velocity" of the train at any particular moment? What is meant by saying "the train was going twenty miles an hour when it passed me"? Not that the train will go twenty miles in the next hour, or that it has gone twenty miles in the hour before; indeed, the train might only run for a few minutes, only go four or five miles, and yet

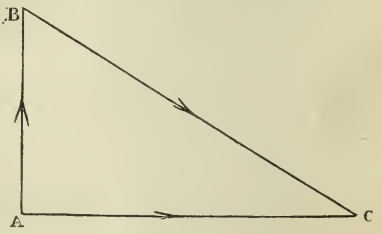


FIG. 5.

the statement might be perfectly true and understandable. The meaning of the sentence may be stated in two ways. The first is this—*If* the train were to keep moving for an hour, and *if* it did not go any faster or slower in that time, then it would go twenty miles. This is not altogether free from objection, but it will nevertheless be of great use in some cases.

Measuring velocities.

The second way of finding the "velocity" of a body whose velocity changes from time to time is derived from the results of section 9. Let a short distance be measured, and notice how long the body takes to pass over this distance. The velocity of the body would not change *much* if a very short distance were taken, so that the

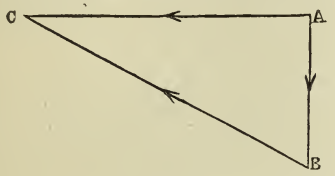


FIG. 6.

result of supposing the velocity not to change at all would be *nearly* true; and the shorter the distance the nearer the result would probably be. Suppose, for example, a train went a quarter of a mile in thirty seconds. Its velocity, *if it did not change at all*, would be $\frac{440 \times 3}{30}$, or 44, which is the same as 30 miles an hour. From this observation you would conclude that the velocity of the train was *about* thirty miles an hour. If you wanted to get a more trustworthy result you would have to take a shorter distance, and notice the time much more carefully. By special contrivances the time of passage of a body can be measured with a wonderful approach to accuracy; and some years ago Captain Noble was able to measure how fast a shot moved *in the cannon*. But no matter how short the distance may be, you can only be sure that the result is *nearly* right. However, this need not trouble us, as it is easy to measure velocities with sufficient accuracy for our purposes.

§ 11. If a body has a velocity 30 at one time, and at some subsequent time it has a velocity 40, the velocity is increased by 10; or we may say the change of velocity is 10, if we understand that this difference is always to be added. If the first velocity had been 40 and the last 30, then the velocity would have been diminished by 10; and in this case we should say the change of velocity was -10 (*minus* 10). The stroke, –, in front of the 10, is read *minus*, and it may be taken to mean "in the opposite direction." A little thought will show you

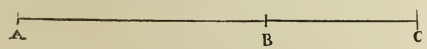


FIG. 7.

that if to a velocity of 40 we add a velocity of 10 in the opposite direction, we get a velocity of 30. In each of these cases, then, "change of velocity" means the velocity that must be

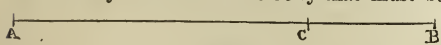


FIG. 8.

added to the original velocity to obtain the final velocity.

It may be well to notice here that the "change of velocity" can be measured in just the same way even when the changed velocity is in a different direction from the original velocity. To explain this it is only necessary to make clear what is meant by "adding together" two velocities which are in different directions. Suppose we have a velocity of 20 towards the south: this may be indicated by a line drawn towards the south, and representing, on any convenient scale, 20 feet. This line would show how far the body would move in one second (provided the velocity did not change). In the same way any velocity in any direction may be indicated in a figure; the direction of the line shows the direction of the velocity, and the length of the line shows the magnitude of the velocity. In fig. 4, let AB represent a velocity, and BC another velocity. If a body had the first velocity it would move from A to B in a second; if it had the second velocity only it would move from B to C in a second; and, by what was said in § 6, it would come to the same place, C, if it performed both motions at once instead of one after the other, so that if the body has both velocities *at once* it would move from A to C in a second. This is the

"Adding together" two velocities.

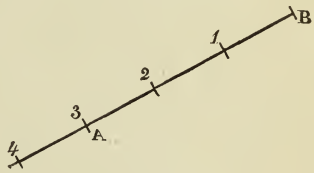


FIG. 9.

same as saying that the two velocities (AB, BC), added together, make up the velocity AC. Or another way of putting the matter is to say that if a velocity AB is changed into another velocity AC, the "change of velocity" is BC.

Let us take some examples, which will, I hope, make the thing clear to you.

Examples.

A velocity of 10 to the north and a velocity of 20 to the south-east are to be added together. Draw AB north, and make its length 10 on any convenient scale (see fig. 5). From B draw BC to the south-east, and make its length 20 on the same scale. Then AC represents the sum of the two velocities. You will find by measuring it that it is about $16\frac{1}{2}$, and its direction is a little bit south of east. You should draw the figure for yourself, as fig. 5 is *not* drawn to scale.

As another example, we will find the change of velocity of a body which moves at first with a velocity of 5 southwards and afterwards with a velocity of 1 to the west. Here the two velocities are represented by AB, AC, fig. 6. You will find by drawing a figure to scale that the change of velocity to BC is about $11\frac{1}{2}$, and its direction is nearly W.N.W. (really a little to the north of this direction).

Here are two examples which you may like to work out for yourself:—

1. Add a velocity of 30 miles per hour east-

wards to a velocity of 30 feet per second northwards.

2. A train is moving 20 miles an hour westwards; at a subsequent time it is moving 30 miles an hour to the south-west. How much has its velocity changed?

This method of adding together two velocities, or finding the change of velocity, holds good when the velocities are in the same line; and in some cases it may prevent confusion if you draw a figure. Take the two cases mentioned at the beginning of this section. In the first case the original velocity is 30 (say eastward). This may be represented by A B (fig. 7). The second velocity is 40 (also eastward). This is shown by A C. The change of velocity is B C; and, as is seen at once, this change is 10 eastward. In the second example the original velocity was 40 (say eastward), A B, fig. 8. The final velocity was 30 (A C). The change of velocity in this case, B C, is 10 *to the west.*

To see if you understand this, try the following example:—A body has a velocity of 15 to the east; afterwards its velocity is 10 to the west. What is the change of velocity?

Changes of velocity.

§ 12. In § 6 we explained what was to be understood by a change of position; and in § 8 we showed how to measure the quickness of this change. With changes of velocity we must deal in much the same way. Already, in § 11, it has been explained what we mean by a change of velocity; and it now remains to indicate how we can measure the quickness with which this change is made. We do this, but without any pretension to exactness, in common talk: thus, when it is said of an express train that it "gets up its speed quickly," or that it "stops quickly," it is meant that the velocity of the train changes much in a short time. This is not sufficient for our purpose; and we must agree upon some means of measuring the rate at which the velocity changes, just as in § 10 we agreed upon a means of measuring the rate at which a body changed its place. We will then observe how much the velocity changes in one second, and this shall be our measure. In other words, the rate at which a velocity changes is measured by the change made in one second. It is convenient to have a special name for this rate; we will call it "acceleration"; so that by *acceleration* we shall understand the *change of velocity per second.*

"Acceleration."

Suppose, for instance, a body is moving with a velocity of 20 feet per second at a certain time, and just one second afterwards its velocity is 27, in the same direction; the acceleration would be 7. Or again, if the velocity was 1000 to begin with, and 1007 at the end of a second, the acceleration would still be 7. You see it does not matter how small or how large the first velocity may be; the acceleration only depends upon the *change of the velocity.* As a third example, suppose a body moving with a velocity 5 is observed to move faster and faster, and at the end of 4 seconds to have acquired a velocity 17. Here the change of velocity is 12, but it takes 4 seconds to complete this change; in *one* second the change would only be the fourth part of 12—that is, it would be 3; in other words, the acceleration is 3 in this case. It is easy to convince oneself that this is right by finding how fast the body is moving at the end of each second. It begins with a velocity of 5; at the end of the first second its velocity is increased by 3—that is, it is 8; at the end of the next second it is 3 more, or 11; at the end of the third second it is 14; and after another second—four seconds in all—it becomes 17, which is right.

The last example will show you how to calculate the velocity of a body when you know how fast it was moving at a given time, and the acceleration. In fact, the whole change of velocity is found by multiplying the acceleration by the number of seconds that have elapsed; and if this change of velocity be added to the original velocity, you have the resulting velocity. For instance, in the last example the acceleration was 3; hence the change of velocity in 4 seconds was 4 times 3—that is, 12; and, as the first velocity was 5, and the change of velocity was 12, it follows that the final velocity was 17.

This rule may be expressed in the form of an equation. Instead of the word "acceleration," we will use the letter a.

An equation.

We have two velocities to deal with: the original velocity, which may be denoted by V, and the velocity produced after a certain time, which may be denoted by v. The number of seconds in the time that has elapsed during the experiment may be represented by t. Then our equation is

$$v = \mathrm{V} + ta.$$

The sign + means "added to"; and the two letters ta, without any sign between them, are to be multiplied together. Bearing this in mind, you will see that the equation expresses the rul given above.

In the examples just given the velocity became greater and greater; and the use of the word "acceleration" was much the same as its ordinary acceptation. But it is not necessary to restrict it in this way. The velocity may become less (so that in popular usage we should speak of a retardation), or the velocity may merely change its direction. In each of these cases we have a change of velocity; and the rate at which the velocity changes is still called the acceleration. I want you to notice that "acceleration" refers to *all* changes of velocity, and not merely to those in which the body moves faster. The equation written above—and the rule—also apply to these cases, although the acceleration may be in a different direction to that of the original velocity. A few examples will serve to make this clear, and will show you how useful is our equation.

It is observed that the acceleration of a railway truck upon an incline is 2. Supposing the truck to be moving with a velocity of 6 up the incline, find the velocity after 2, 3, and 4 seconds respectively. Here we have two directions—one up the hill, the other down the hill. One of these must be selected as the principal or "positive" direction, and the other will

then be the "negative," or — direction. We shall choose "down the hill" as the positive direction; but just the same result would be obtained if we took "up the hill" to be positive, and it will be worth your while to try this for yourself. The acceleration or *a* is 2; the initial velocity or V is —6. To find the velocity after 2 seconds, we must add twice the acceleration—that is, 4—to the V; in other words, we must add together a velocity of 6 uphill and 4 downhill; the result is 2 uphill or —2. At the end of 3 seconds the change of velocity is three times the acceleration, or 6; and the velocity at the end of 3 seconds is found, by adding a velocity of 6 downhill to a velocity of 6 uphill, to be nothing: in other words, the truck comes to rest at the end of 3 seconds. In 4 seconds the change of velocity is 8; and this added to the original velocity, 6, makes 2, so that at the end of 4 seconds the truck would be moving *downhill* with a velocity 2. These results may be illustrated by a figure. Let A B (fig. 9) represent the velocity of the truck at first; and B 1 the acceleration or change of velocity in one second. Mark off on the line 1 2, 2 3, 3 4, each of them equal to B 1, and in the same direction; then the lines A 1, A 2, A 3, A 4 show the velocities the truck will have at the end of 1, 2, 3, and 4 seconds; and, as above, we find that the truck has *no velocity*—it is at rest—at the end of 3 seconds, while at the end of 4 seconds it is moving downhill.

ST. BURCKHARDT'S CHURCH, WURTZBURG.

XXX.

THE THIRTY YEARS' WAR (*continued*).

THE news of the fall of Magdeburg was received with a general cry of anger throughout Germany. Since the massacre of St. Bartholomew no such deed of horror and shame had been committed in the profaned name of religion. Again the lesson had been impressed upon the Protestant princes that the tender mercies of fanatics are cruel, and that in union alone is safety to be found. The landgrave William of Hesse Cassel made a league with the Swedish king; and even the elector of Saxony, alarmed at the approach of Tilly, who was advancing with his army to punish him for the Leipsic confederation, invoked the protection of Gustavus Adolphus. The Swedish king was at some pains to prove to Germany that he could not arrive before Magdeburg in time to save it, and marched fearlessly to encounter the renowned imperialist commander.

Activity among the Protestants.

At Leipsic, on the "Broadfield" (Breitenfeld), the armies met. Schiller, in his admirable "History of the Thirty Years' War," says that on this day Tilly was for the first time disturbed and doubtful. "Dark and gloomy forebodings clouded the native clearness of his mind; the shadow of Magdeburg seemed to lour upon him. On the other hand, stern resolution and confidence marked the bearing of the Swedes, whose king, kneeling in front of the assembled army, uncovered his noble head and prayed that God would defend the right. 'God with us!' was the battle-cry of the Swedes; 'Jesu Maria' that of the imperialists. The conflict was hot and stubborn; but in the end the Swedes triumphed everywhere. Tilly and Pappenheim fled from the field, with the loss of 7,000 killed and 5,000 prisoners, their camp, baggage, and artillery."

Battle of Breitenfeld, Sept. 7, 1630.

This Leipsic disaster reversed, in a single day, the triumphs that a dozen years of fighting and intrigue had procured for the house of Austria. The name of Gustavus Adolphus was a beacon of hope to the Protestants of Germany; the Saxons under Field-marshal Arnim occupied Prague. The terror of invincibility had departed from Tilly's name; that baffled general was obliged to retreat southward,

while Gustavus triumphantly marched towards the Rhine. Schiller narrates how, with the sword in one hand and mercy in the other, he traversed Germany as a conqueror, a lawgiver, and a judge; while the keys of towns and fortresses were delivered to him by the inhabitants as to their native sovereign.

Würzburg, Mayence, Worms, Manheim, Speyer, thus paid homage to him; and the king's universal popularity, together with his energy and perseverance, gave rise to the opinion that he intended to establish himself firmly in Germany, and perhaps even to aspire to the imperial crown. This excited the suspicions of the elector of Saxony, who accordingly acted with great caution in Bohemia, not wishing to make the emperor's enmity irreconcilable. Tilly meanwhile had in some degree recovered from his defeat at Leipsic; and once more encountered Gustavus at the banks of the Lech, where he took up a strong position to defend the Bavarian frontier. But the Swedish king was again victorious; Tilly's army was routed, and he himself received a wound in the leg, and was carried off the field. He died a fortnight later at Ingolstadt. Tilly was a man whose whole soul was filled with ideas of war. He despised magnificence and pomp, cared nothing for titles and wealth, lived with Spartan simplicity, and pursued war as the business of his life, without seeing that "there exists a higher than the warrior's excellence," and that "in war itself war is no ultimate purpose."

Defeat and death of Tilly at the Lech, April 20, 1632.

The Swedish king now marched triumphantly into Bavaria, and occupied Munich. The position of the Emperor Ferdinand was now extremely critical, with the Saxons in Prague, Gustavus in the Bavarian capital, and Tilly dead. A new army was imperatively required; and there was one man, and one man only, in the empire, Albert Wallenstein, whose name had already been potent to collect an army, and might save the empire in this emergency. To Wallenstein, therefore, who had been living in ostentatious and magnificent retirement in Bohemia, Ferdinand now sent envoys, inviting him to resume the command of the imperial forces, or rather, to raise an army in the emperor's name. Wallenstein, whose haughty soul had been deeply stung by the humiliation of his dismissal, had now an opportunity of tasting the sweetness of revenge. He affected great reluctance to mingle in the war; and at length consented to assume the command of an army he was himself to raise, under conditions that put him in the position of an independent prince rather than of a subject. He was to be generalissimo of all the armies of both branches of the Austrian house, to carry on the war, levy contributions, and pronounce confiscations with dictatorial power, to appoint all colonels of regiments, and to receive the duchy of Mecklenburg or a principality of equal value in pledge, as a guarantee for the expenses he should incur. Thus Wallenstein reappeared in more brilliant fashion than ever on the theatre of war. The magic of his name was sufficient to bring crowds of adventurers to his banner when the recruiting drum was beaten. Germans and foreigners, Catholics and Protestants, all who had strong arms and willing hearts, were equally welcome in that extraordinary body of robber-soldiers—that collection of fragments welded into a solid mass by the terror and attraction of a single name. Within three months forty thousand men were assembled; the number increased every day, and Austria once more looked forward with confidence of victory.

Wallenstein's recall.

But, to the astonishment of Europe, Wallenstein turned all these preparations, not against Gustavus Adolphus in Bavaria, but against the Saxons in Bohemia. To drive these enemies out of the country was an easy task; but the evident willingness of Wallenstein to negociate with the enemy aroused suspicion of his intentions in Vienna, where the government already began to regret the terms on which they had purchased the aid of the great leader and of his freebooting followers. On the urgent representations of Maximilian of Bavaria, and the exhortation of the emperor, Wallenstein at length united his troops, now numbering 60,000, with the elector's forces. Gustavus Adolphus had taken up a strong position near Nuremberg; and here Wallenstein entrenched himself securely near the town; and the eyes of Europe were fixed on the two great leaders, in expectation of a decisive battle. But though Gustavus, whose army suffered grievously from sickness in an unaccustomed climate, offered battle to the imperialists, Wallenstein kept strictly on the defensive; and after suffering great loss in a desperate attempt to storm the imperialist camp, the Swedish king was compelled, by the failure of supplies in the famine-stricken district, to draw off his troops in the direction of Swabia. Wallenstein, whose conduct during the whole campaign was equivocal, and who seemed always ready to build a golden bridge for a retreating enemy, withdrew towards Saxony, where Pappenheim joined him. Gustavus, chivalrously responding to the appeal of the alarmed elector, hastened with forced marches towards the Saale; and now at length, on the 6th of November, 1632, near a little Saxon town, destined a hundred and eighty years later to be rendered memorable by one of the last victories of the great Napoleon, the long-expected encounter between the two great rivals took place.

Crafty conduct of Wallenstein.

The camp at Nuremberg.

At the battle of Lützen the career of Gustavus Adolphus found a termination as glorious in every element of heroism and pathos as the death of Nelson amid the thunder of the great day of Trafalgar. To some extent the features of Breitenfeld were reproduced. Again the Swedish war-cry, "God with us," was answered by the shout of "Jesu Maria" from the imperialists; again the king knelt on the field of battle and implored the divine blessing on the army and the cause. Then,

Battle of Lutzen, Nov. 6, 1632.

with an attack by the Swedes on the intrenched position of the enemy, the battle began. It was long and obstinate. Early in the day the king fell, pierced by several bullets, in the thickest of the fight. Bernhard of Weimar then took the command; and the Swedes, maddened with rage at the loss of their king, fought like giants to avenge him. Pappenheim, the most trusted of Wallenstein's lieutenants, was borne from the field mortally wounded. The "yellow guard ' of Gustavus fell almost to the last man, around the spot where the body of their king was found. The fierce contest continued until the November darkness hid the combatants from each other; but the victory was with justice claimed by the Swedes, for when on the next morning their bands were marshalled to renew the fight, the enemy had disappeared. Wallenstein had broken up his camp in the night, leaving his watchfires burning to deceive his opponents, and was retreating towards Bohemia. Thus the troops of Gustavus, with their Saxon allies under Bernhard of Weimar, won the most mournful triumph of the war, dearly purchased by the death of their king. Gustavus Adolphus is the most heroic character of this dark period—the only one of the great actors in the scene whose glory is not dimmed by the mists of vainglorious and selfish ambition. He died in his thirty-ninth year, in the zenith of his fame. His sun went down suddenly, at noonday; his singleness of purpose, and the rugged enthusiasm with which he fought for the liberties of the German people, won for him the heart of the nation; while all Europe admired the warlike prowess and valour of the "lion of the north." "For Gustavus Adolphus," says Ranke, "the evangelical name was everything. He fought for the maintenance of Protestantism with his whole heart. He had made this idea the principle of his rule in the army. He himself belonged to the Protestant side with a hearty, joyous conviction; a man of a cheerful nature, thoroughly popular, the man for the German citizens, who would gladly have welcomed him even as their master. The honour that was paid to him seemed to him almost too great."

Retreat of Wallenstein.

A very different man disappeared at the same time from the scene. Eleven days after the battle of Lützen the Elector Frederick, the deposed "winter king" of Bohemia, expired at Mayence. His ambitious and spirited consort, the English princess Elizabeth, survived him thirty years; and her life, chequered by such high hopes and such deep misfortune, ended at length in the country of her birth, at the court of her nephew Charles II.

Death of the Count Palatine Frederick.

The death of Gustavus Adolphus entirely changed the aspect of the war. The great reason which had rendered Wallenstein's aid indispensable no longer existed; and the desire at Vienna to decrease the power of that ambitious man was heightened by the equivocal conduct of the general himself, who showed little energy in prosecuting the war, and again appeared more ready to negociate with the emperor's enemies for purposes of his own than to meet them in the field. The council that ruled the Swedish empire during the minority of Christina, the daughter of Gustavus, determined to continue the war; and the Swedish chancellor Oxenstiurna conducted it with great sagacity. Wallenstein opened a negociation with him; and though he gained a victory over the Swedes at Steinau, he retired with his army to Bohemia, liberated Count Thurn. the great enemy of the emperor, and allowed Bernhard of Weimar to gain fresh laurels for the Protestant arms, and even to take the bulwark of Bavaria, Ratisbon. The court at Vienna now declared that Wallenstein was ambitiously and treasonably taking advantage of his position to put things in such a position that the emperor would be forced to accept any peace he might dictate. He was supposed to covet the crown of Bohemia, or an equivalent principality (some said the Palatinate, with the title of Elector), for himself. Moreover, his decided refusal to allow his army to be weakened by the despatch of eight thousand horse, required to accompany the infant Don Fernando into the Netherlands, and the avowed intention of the colonels of his different regiments, who bound themselves by a written contract to remain faithful to him, and to resist every attempt to detach them from his banners, were circumstances skilfully used against the duke by his numerous enemies at court. The emperor was persuaded that Wallenstein was a traitor, and intended to treat the emperor as Maurice of Saxony had treated Charles V. The Jesuits, and especially the emperor's confessor Lamormain, who hated Wallenstein as a man who had not the extirpation of Protestantism at heart, induced Ferdinand to encounter the suspected treason of Wallenstein with a similar weapon. A conspiracy was formed for the assassination of Wallenstein and of his chief advisers, the generals Terzky, Illo, and Kinsky. Thereupon the duke was proclaimed an outlaw, and deposed from his offices. He set out with those troops who still remained faithful to him, towards the frontier town of Egra, to effect a junction with the Saxons and Swedes; but at Egra, in the night of the 25th of February, 1634, he and his friends were murdered by some troopers, under the command of three foreign officers, Butler, Leslie, and Gordon, in authority in the garrison at Egra. Ferdinand showed some emotion on hearing the news of the great general's death; but he rewarded the murderers with unusual liberality; and, for the quieting of his conscience, ordered that three thousand masses should be said for the souls of the slaughtered chiefs. "Thus," says Schiller, "died Wallenstein, the terror of the nations, the idol of the camp. He possessed a bold, enterprising spirit, an imperious manner, heightened by the gloomy sternness of his countenance and the taciturnity of his nature, and a pride and ambition that knew no bounds. When his lofty figure strode

Ratisbon taken.

Assassination of Wallenstein, Feb. 25, 1634

through the camp, attired in the red cloak, and with the scarlet-feathered hat, the soldiers were seized with a strange terror. . . . Religious questions had a secondary value in his eyes; on the other hand, his powerful spirit bowed down before imaginary powers of destiny; he believed in astrology. What his imagination, heated by ambition, thought to read in the stars, was fashioned in his dark, close-shut soul into deep and secret schemes. The gloomy form of Wallenstein still lives in legend and song among the mountaineers of the Silesian and Bohemian borders."

ZOOLOGY.

IV.

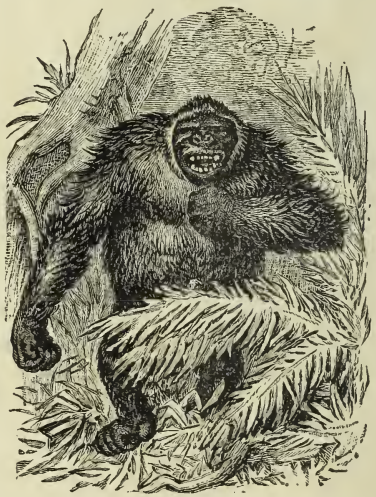
THE SUB-KINGDOM VERTEBRATA.

THE human species, as well as monkeys and apes, belongs to the great division of animals called the sub-kingdom *Vertebrata*, or those possessing a backbone.

Backbone.

This in general consists of a bony or gristly axis passing through the body from one end to the other, composed of a series of discs fitting against one another, and capable of being slightly moved upon one another so that the body can be to some extent bent in a curve. This backbone is really continuous with the skeleton of the head, and acts as a partition between two important cavities. The upper and smaller one nearest to the back, which encloses and protects the brain and spinal cord, is called the brain-case and spinal canal. The lower and larger has several parts, as the mouth, the chest, the abdomen; but collectively they enclose the principal organs of digestion and breathing, with the heart and large blood-vessels.

Body with two main cavities.



GORILLA.

There are some vertebrates which possess no limbs; but in those which have them the number is definite, never more than two pairs, and their structure contrasts greatly with limbs such as those of the lobster. There is an internal hard skeleton in the vertebrate limb, which is covered by the muscles which move it; the lobster's leg has an external skeleton, enclosing in its interior the muscles by which it acts.

Limbs.

The jaws of vertebrates open more or less horizontally, and work up and down; whereas many invertebrates, such as lobsters, have jaws which open vertically, and work from side to side. In nearly all cases they are provided with hard teeth in the mouth, working upon one another, and aiding in biting and chewing food.

Jaws and teeth.

Vertebrates include all true fishes, of which herrings, mackerel, and trout are familiar examples; frogs, toads, newts; reptiles proper, including snakes, lizards, turtles, and tortoises, crocodiles, and alligators; birds; and mammals.

MAMMALIA.

It is to the latter group that our ordinary quadrupeds, as well as monkeys and mankind, belong. It is founded especially on one great characteristic—that the females possess glands destined to secrete milk for the nourishment of their young, which are born in a condition in which they cannot obtain their own food. Mammals have an outer covering more or less developed, in the shape of hair; contrasting with the feathers of birds, the scales of snakes and fishes, and the naked bodies of frogs. Their skull is fitted on to the spinal column by means of two rounded surfaces called condyles, while all birds and reptiles have but one. The lower jaw is formed of but one bone, which is attached directly to the side wall of the brain-case; in other vertebrates it is made up of several pieces, and is pushed to a distance from the brain-case by one or more distinct bones. While the heart is in the main similar to that of birds, having four principal cavities, its great vessel, the aorta, supplying blood to the general system, curves towards and lies on the left side of the body, while in birds it is situated on the right side. The other vertebrates besides these have either fewer cavities, or more than one principal blood-vessel or aortic arch. No mammal breathes air dissolved in water, or ever possesses gills; after birth, breathing takes place by lungs in air. Mammals that live in water, such as whales and porpoises, require to come to the surface of the water periodically to take in air for respiration.

Suckling.

Hairy covering.

Two condyles.

Jaws.

Heart.

Order Primates: Man, Monkeys, Apes, Lemurs.

The highest group in the animal kingdom is of course that which includes man; his associates in the group being those creatures which are nearest to him in structure, general form, and aspect. Generally known as monkeys* and apes, they are distinguished by some of their natural actions being similar to those

* The word monkey appears to be derived from mannikin, a little man.

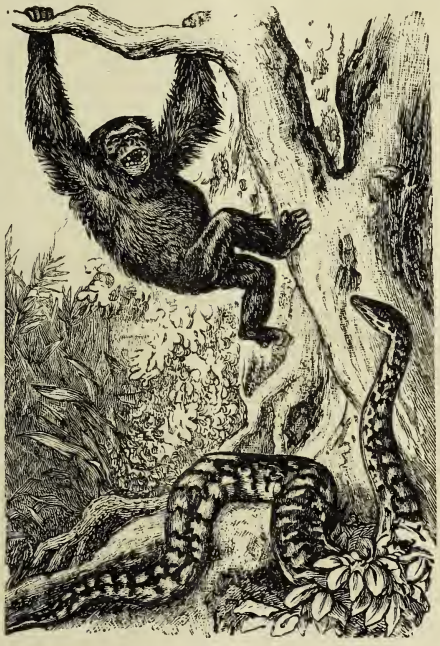
of mankind, and by their more noticeable capacity of imitating many operations performed before them. But zoologists have to associate with these a group of very strange creatures, the lemurs, in which these qualities are much less noticeable, if at all.

The name given to this great assemblage or Order is *Primates*, or first in rank. Popularly speaking, they are said to possess four hands, or to be quadrumanous; but anatomically this is not quite correct. The great toe, or hallux, can be moved more or less extensively inwards or outwards, and bent downwards and inwards so as to approach or touch others of the toes, so that there is a strong resemblance to a thumb. But the termination of the leg always retains certain characters by which it is plainly contrasted with the hand; the foot in primates always remains a foot, by the same distinctions as are found in general to hold good between feet and hands. Another feature about the great toe is that it always possesses a flat nail, contrasting it with those forms in which it is slender, stout, elongated, and sharp, forming a claw; and with those which have clubbed nail-masses or hoofs.

First digits opposable.

Almost invariably the three principal kinds of teeth are found in primates: *incisors*, or front or cutting teeth; *canines*, or eye-teeth, next to incisors in position; and *molars*, or grinders; while many quadrupeds have less complete sets. There is a limit to the number of these teeth, the incisors never exceeding two in number on each side of the middle line, above and below, or eight in all; the canines are four; and the molars never more than six on each side above and below, or twenty-four altogether; thus thirty-six is the greatest number of teeth existing in the order. The females have always two mammary or milk-secreting organs situated upon the sides of the front of the chest. In most other respects the essential features of anatomy are the same throughout, so that a knowledge of human anatomy may serve for the understanding of the other members of the group.

Teeth.



CHIMPANZEE. ROCK SNAKE.

PRINCIPAL DIVISIONS.

The divisions of the order are three:— 1. The Lemurs. 2. The Apes and Monkeys. 3. Mankind. Taking the middle group, or *Simiadæ*, we find among them many which usually walk on all-fours, though they may be capable of standing erect; but others approach man in holding the trunk habitually in the inclined or semi-upright posture. Walking and running are as natural to monkeys as to man, but the former are far more capable of climbing, their whole structure being specially adapted, in some cases, to life in trees. Particularly, the mobility of the great toe, and its opposability to the other digits, are much greater in the monkeys than in man; and this aid to climbing is supplemented in many by a long and strong tail, as useful as a fifth limb.

Locomotion in Simiadæ.

As a rule the whole body in monkeys is thickly covered with hair, and if in any quarter there is an excess in quantity, it is usually on the back; while in man the crown of the head has the longest and thickest hairy covering, and a very large proportion of the trunk and limbs may have merely short soft hairs. In man, again, the teeth form a regular series, without any space between them, and they all reach almost to the same level in height. In monkeys, however, there is a space (called a *diastema* or interval) in front of the upper canine tooth and behind the lower canine; the lower tooth, when the mouth is closed, fits into the upper space, and the upper into the lower space. This corresponds with the fact that the canines are longer than the rest of the teeth, and sharply pointed.

Hairy covering.

Intervals in teeth.

The brain-case is much smaller in all monkeys than in any human skull yet discovered; its capacity never rises above forty cubic inches, or two imperial pints, in any monkeys. The distinctions between the form and structure of the brain in the two highest groups are but slight compared with their common differences from all other brains; they are chiefly matters of size, and small changes in the relative proportion of parts. But monkeys are very much contrasted with lemurs in their brain-case and brain. In lemurs the brain-case is small relatively to the face, and narrow in front; while in the other members of the class it is large, and broader in front. Its form and position approach much more closely to those of lower orders of mammals. The brain in lemurs has comparatively small cerebral hemispheres,

Brain-case and brain.

Contrasted with lemurs.

corresponding to the principal mass of the brain in man. These even do not extend the whole length of the brain, but are so short behind as to leave uncovered a large portion of the underlying division—the cerebellum, or little brain. Again, the furrows and convolutions in the cerebral hemispheres are much more scanty than in monkeys and man, and the lobes from which the nerves of smell are supplied are large and partially exposed in front of the brain proper, instead of being small and entirely concealed beneath it.

We thus perceive how distinct a position the group *Simiadæ* holds in the present creation. If we inquire into the records of the past, we find that in different parts of the world skeletons of monkeys have been unearthed, sometimes in regions, as in France, where they do not now live. Some of them resemble very closely living forms; others depart from them so much as to form distinct genera; many are considerably larger in size than those now existing. But the most important fact is that they are as distinctly monkeys as those now living; there are none which show transformation from the lemur type to the monkey, or from the monkey form to that of man. It is to be borne in mind, nevertheless, that the numbers of skeletons of monkeys discovered is very small compared with the number of species and individuals now on the surface of the globe. Also they have as yet only been discovered in rocks of modern formation in geological time, although apparently dating back for hundreds of thousands of years.

Fossil monkeys.

XXX.

Division of Decimals (*continued*).

We can now see the truth of the following rule, which is applicable to all cases, and includes all three rules.

To find the quotient to any number of decimal places.—See that the number of decimal places in the dividend exceeds the number of decimal places in the divisor by at least as many decimal places as we wish the quotient to have. (This is effected by annexing ciphers, if required, to the dividend.) Then divide as in whole numbers, taking no notice of the decimal point; and in the quotient so found, mark off as many places of decimals as the number of places in the dividend exceeds the number in the divisor.

It is evident that we can make the quotient to have as many figures as we like by simply annexing to the dividend a sufficient number of ciphers, or, what comes to the same thing, by supposing them annexed, and bringing them down in succession in the division.

Example.—Find the quotient of 76·31 divided by 3·241.

```
3·241)76·310000(23·545
      6482
      ----
     11490
      9723
      ----
     17670
     16205
     -----
      14650
      12964
      -----
       16860
       16205
       -----
         655
```

Here, suppose we wish the quotient to have three decimal places, we must annex at least four ciphers to the dividend. Having done this, we divide as in whole numbers, and we get the quotient 23545, and remainder 655. Now, since there are six places of decimals in the dividend, which is three more than the number in the divisor, we must cut off three places in the quotient, which thus becomes 23·545.

Now, what is to be done with the remainder?

If we annex a cipher to it, and go on one step more with the division, this would evidently be equivalent to annexing another cipher to the dividend, which would give us another figure in the quotient, and as we should have to cut off one more decimal place, the decimal point would remain in the same position.

Hence we see we may continue the division as long as we like while there is any remainder, annexing a cipher to it, and getting another figure in the quotient for each cipher thus annexed.

For instance, taking the above remainder 655, we may continue the division as follows:

```
3·241)6550(20209
      6482
      ----
      6800
      6482
      ----
     31800
     29169
     -----
      2631
```

We annex a cipher to 655 and divide. This gives quotient 2 and remainder 68. Annex a cipher: the divisor won't go into 680; so write 0 in quotient, and annex another cipher to 680, and so on. We thus get as quotient 23·54520209; and we may continue the division still further, if we please.

Another example.—Find the quotient of ·051 ÷ 3·122.

```
3·122)·05100(1633
      3122
      ----
     19780
     18732
     -----
      10480
       9366
       ----
      11140
       9366
       ----
       1774
```

Here we have annexed two ciphers to the dividend, and have also annexed three ciphers to the three successive remainders, which is equivalent to annexing them to the dividend. The dividend may therefore be considered to have eight decimal places, which is five more than the divisor has. Therefore we must have five decimal places in the quotient; and as we have only four we must make up the deficiency by prefixing a cipher and then putting the decimal point.

Ans. ·01633 and a remainder.

Thus the quotient is ·01633.

This, of course, is not the *true* or *exact* quotient, because there is a remainder. We can, if we wish, annex another cipher to this remainder and continue the division, and we may proceed in this way so long as there is any remainder.

This inexact quotient is called an *approximation* (i.e. *approach*) to the true or exact quotient. Every fresh step in the division gives an additional figure in the quotient, and thus makes it nearer to the true value.

This can be clearly proved in the following way.

The true quotient is $= \cdot01633 +$ something,
$= \cdot01633 + x$,
where x stands for the unknown "something," which may be written in any of the following ways, viz.—

$= \cdot01 + \cdot00633 + x$,
or $= \cdot016 + \cdot00033 + x$,
or $= \cdot0163 + \cdot00003 + x$,
or $= \cdot01633 + 0 + x$;

from which it is clear that ·016 is nearer the true value than ·01 ; ·0163 nearer than ·016 ; and so on.

When we wish to take only a certain number of decimal places as an approximation to the true quotient, we shall be nearer the true value if we increase the last figure of this approximate quotient by unity, provided the next figure is more than 5.

For instance, suppose we have the decimal ·76382, and we wish to keep only three places of decimals, then ·764 will be more correct than ·763. But if we wish to keep four places we should have ·7638, not ·7639, ∵ the next figure is less than 5.

This will be evident if we take an example.

Suppose in some example we have found the quotient ·2348....., and we wish only to take three places of decimals, we shall be nearer the truth if we take ·235 than if we take ·234. For the excess of ·235 above ·2348 is = ·0002, whereas the defect of ·234 below ·2348 is = ·0008 ; so that ·234 is further below the true value than ·235 is above it, and therefore there is a smaller error involved in taking the larger number than in taking the smaller. Neither value is correct, one being too large and the other too small, but the larger value is not so far away from the truth as the smaller. Thus the successive approximations to the decimal ·7634987, according as we take one, two, three, etc., figures, are ·8, ·76, ·763, ·7635, ·7635, ·763499.

Exercises in Division of Decimals.

(*a*) 74·151 ÷ 2·31
(*b*) ·0000001 ÷ ·0001
(*c*) ·07504 ÷ 23·45
(*d*) ·000602 ÷ ·0002
(*e*) 146·4561 ÷ 33·21
(*f*) 723·6 ÷ 32·16
(*g*) 2·50625 ÷ 1·0025
(*h*) ·0000000576 ÷ ·000012
(*k*) ·00003216 ÷ ·005025
(*l*) 4687·5 ÷ ·00025
(*m*) 3·125 ÷ 25000
(*n*) 171·99 ÷ 9·1
(*o*) 362·6 ÷ ·00037
(*p*) ·015625 ÷ ·0025
(*q*) ·15625 ÷ 250
(*r*) ·3 ÷ ·01
(*s*) 906·5 ÷ 4·9
(*t*) 170845·92 ÷ ·024
(*u*) ·0000128 ÷ ·08192.

Answers.

(*a*) 32·1 ; (*b*) ·001 ; (*c*) ·0032 ; (*d*) 3·01 ; (*e*) 4·41 ; (*f*) 22·5 ; (*g*) 2·5 ; (*h*) ·0048 : (*k*) ·0064 ; (*l*) 18750000 ; (*m*) ·000125 : (*n*) 18·9; (*o*) 980000 ; (*p*) 6·25 ; (*q*) ·000625 ; (*r*) 30 ; (*s*) 185 ; (*t*) 7118580 ; (*u*) ·00015625.

XXIX.

THE SUN (*continued*)—SPECTRUM ANALYSIS

THE discoveries mentioned in our last article, though very important, would not by themselves have thrown much light on the constitution of the sun or stars, for these bodies do not give spectra of bright lines, like those yielded by incandescent vapours. But these discoveries did not stop here; still further discoveries had been made. Thus it was found that if the light coming from a white-hot solid body, and yielding therefore a continuous rainbow-coloured spectrum, was made to pass through some sodium vapour, it no longer gave a simple continuous spectrum, as before, but the rainbow-coloured spectrum was now crossed in the orange-yellow by two black lines, in exactly the position where the hot sodium vapour would show its two orange-yellow lines. Other bodies were found to give the same results; thus hydrogen gas cut out three dark lines, one in the red, one in the greenish-blue, and one in the violet, in exactly the same place where lines of these colours would appear in its own spectrum. Thus, whenever the light coming from an incandescent solid body traverses a cooler gas, that gas cuts out from the continuous spectrum dark lines exactly corresponding in position with the spectrum it gives when it is itself incandescent. It was thus easy, from an examination of dark lines crossing any continuous spectrum, to tell through what gaseous bodies the light had passed ere it reached the observer.

Dark line spectra.

This is of course a very slight outline of the foundation of the branch of science now known as spectrum analysis, but it will be sufficient to enable any one to understand the principles of this method, and the means by which astronomers have been able to determine the constitution of the gaseous envelope forming the visible portion of the sun.

The fundamental principles of this analysis may be summed up as follows :—

1. Every solid and liquid body when incandescent gives the same continuous rainbow-like spectrum.

2. Every gaseous body when incandescent gives a characteristic spectrum consisting of a number of bright-coloured lines.

3. Every gaseous body when traversed by a pencil of light absorbs the light-waves corresponding to its own characteristic spectrum,

and yields a bright-coloured continuous spectrum crossed by dark lines in the same position as the bright lines in its own spectrum.

4. A gaseous body at very high temperature and very dense gives a continuous spectrum.

When the spectrum of the sun came to be examined by means of the spectroscope, or instrument used for obtaining the spectrum of a pencil of light, it was found to be a continuous rainbow-coloured spectrum crossed by an immense number of narrow black lines. The existence of these lines in the spectrum of the sun had long been known, as they had been discovered by Fraünhofer nearly fifty years before, and were commonly known as Fraünhofer's lines. Then their origin and meaning were unknown: now these discoveries rendered it easy to interpret them. The white-hot lower-lying strata of the solar atmosphere gave a continuous spectrum, and the solar light in traversing the cooler upper-lying strata of the gaseous envelope, had cut out from it the light corresponding to their spectrum, so it emerged crossed by black lines corresponding in position to the spectrum of every constituent in the upper-lying layers of the solar atmosphere. It was only necessary, therefore, to identify these lines, to at once ascertain what were the constituents of the solar atmosphere. Three of the principal lines, in the red, greenish-yellow, and violet, were at once seen to correspond to the three lines in the spectrum of hydrogen; a pair of very close lines in the orange-yellow agreed exactly with those of sodium; three close lines in the green with those of magnesium; others with those of iron, nickel, etc. It follows, therefore, that the constitution of the upper layers of the solar atmosphere is perfectly analogous to what might be expected from terrestrial analogies—in fact, similar to what would be the constitution of the gaseous envelope to the earth were it suddenly raised to the same temperature as the sun. So far, therefore, as our knowledge extends, the chemical constituents of the sun are in every way similar to those of the earth; and extending the reasoning, we may consider it tolerably certain that the entire solar system is composed of compounds of the same elements as those found in the earth.

Spectrum of the sun.

Elements present in sun.

With the aid, therefore, of the additional information given us by the spectroscope, it is not very difficult to form a true idea of the probable condition of the surface of the sun, which is all that we can see. It is the upper-lying strata of a very dense atmosphere of very high temperature—an atmosphere agitated by storms, whirlwinds, and cyclones of all kinds, traversed by innumerable currents, and now and then broken by violent explosions. Above the brilliant surface which we see is a less dense and somewhat cooler upper stratum, which, though hot enough to shine quite brightly, is quite invisible in the presence of the brighter strata beneath it. Just before, or after a total solar eclipse the existence of this cooler stratum has been revealed by the spectroscope. We know that if we pass a beam of light through a mass of hot sodium vapour we obtain a continuous spectrum crossed in the orange-yellow by the two dark lines indicating sodium; but now if we cut off the beam of light, then the sodium vapour gives us its two bright orange-yellow lines. It is the same with the sun: the existence of this cooler outer envelope is indicated by the numerous dark lines shown by the solar spectrum, but cut off the light coming from the lower-lying dense strata of the solar atmosphere, so as to get rid of the continuous spectrum, and then this upper-lying layer gives its own bright-line spectrum. Hence, as just before the beginning of totality in a solar eclipse the moon cuts off all the light coming from the lower-lying strata, and for a second or two lets pass only the light from the extreme edge of the sun, or the light from the uppermost strata, so during this instant the continuous spectrum, with all its dark lines, ought to be replaced by a spectrum of many brilliant-coloured lines. This was first seen by Professor Young, and since then has been witnessed by other astronomers. The existence of this absorbing medium explains why the portion of the sun near the edge of the disc, or limb as it is called, is not so bright as the central portions; for the light from these portions having to pass through a greater thick-

Solar atmosphere.

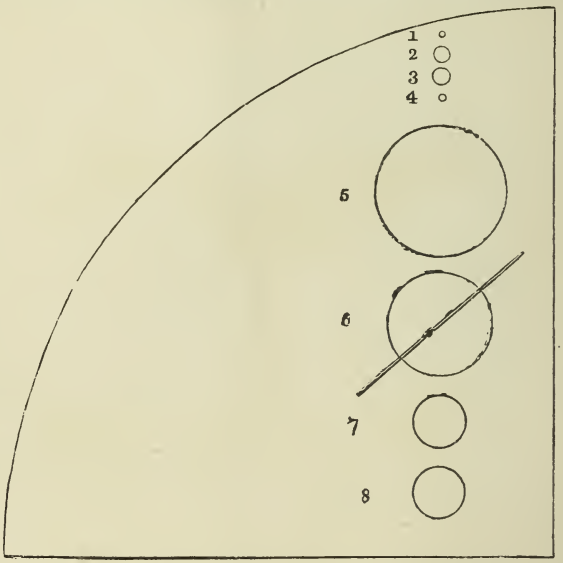


FIG. 76.—PLANETS COMPARED WITH A QUARTER OF THE SUN.

1. Mercury. 2. Venus. 3. The Earth. 4. Mars. 5. Jupiter. 6. Saturn. 7. Uranus. 8. Neptune.

ness of atmosphere, they lose a greater portion of their light by absorption.

Reference has already been made to the curious *red prominences* or *flames*, seen round the sun during solar eclipses. The spectroscope soon showed these to be no other than immense masses of incandescent hydrogen gas. By means of the spectroscope these can now be studied at all times when the sun is visible, it no longer being necessary to wait for solar eclipses. It is found that all round the sun there is an envelope of incandescent hydrogen gas; but that here and there it projects outwards in the enormous protuberances which have been seen in solar eclipses. These prominences take all sorts of curious forms and shapes, and at times vary from hour to hour in shape and dimension. At times they have been seen to rise quickly in enormous cloud-like masses, as if hurled upwards by some tremendous explosion below, and sway and bend into a thousand fantastic shapes whilst you watch them. Occasionally these prominences show the lines of sodium, and of some unknown element, showing that they consist at times of the vapours of these bodies as well as of merely hydrogen. (See figs. 74, 75, pp. 68, 69.)

Red prominences.

When the solar surface is closely examined, it is found to be curiously mottled over as if with pores. With more powerful telescopes this is seen to be due to the surface being composed of innumerable brighter granules on a darker ground. These granules have been likened to *rice grains* by some astronomers, and to *willow leaves* by others; they are most likely the summits of the rounded cloud-like masses which probably constitute the visible surface of the sun. In places, but especially in the vicinity of spots, are to be found the bright patches called *faculæ*, which seem to be masses of denser or brighter vapour that have been hurled to the surface by the same violent internal agitations or storms which create the spots themselves. At other times they would appear to be the bases of the solar prominences or red flames.

Solar granules.

The *dark spots* themselves would seem to be due to either uprushes from below or to downpours from above, or perhaps at times to one and at times to the other; in both cases there would result a break in the bright-lighting strata by masses of cooler vapour. They would thus correspond to whirlpools or cyclones in the solar atmosphere. Imagine some terrible disturbance beneath the surface to hurl dense masses of gas to the surface, breaking through the visible bright layer; as the dense masses of gas rose the pressure would diminish with tremendous rapidity, and the gases would expand enormously, causing a great reduction in the temperature of the gas, and so rendering it much cooler. It would thus evolve less light and appear as a dark spot upon the sun. The whole appearance of the solar spots is in thorough accord with this explanation of their probable origin.

Nature of solar spots.

It was early discovered that the spots seemed far more numerous near the equatorial region of the sun than elsewhere, rarely appearing in greater heliographical latitudes than 35°, though occasionally spots have been seen at a greater distance from the equator. In dimensions they are, as a rule, not greater than 10″ or 15″, but at times have been known to exceed 50″ in diameter; whilst groups of spots with more or less common penumbræ have exceeded even this in dimensions. When it is remembered that 1″ on the solar surface corresponds to over 400 miles, the immense dimension of these spots may be understood. It has already been mentioned that they undergo well-marked periodical variation in their frequency—at times scarcely any being visible, and at others there being hardly a day when four or five cannot be seen. Further investigation seems to show that the three periodical variations have a mean period of 11·11 years, but at times the epochs of maximum are separated by longer or shorter intervals than this,—two maxima being at times separated by only eight years, and at others by as much as thirteen years. Some astronomers have fancied that they have traced a correspondence between the variation in the number of sun-spots and the terrestrial magnetic variation, with the number of auroræ, terrestrial cyclones, famines, and many other things; but all these deductions rest on very imperfect data. The mere coincidence in mean period so strongly insisted on by some observers necessarily proves nothing, because such coincidence must be found for every period if only diligently searched for. Other astronomers have ascribed the formation of the spots to the action of the planets, and especially of Jupiter; because that giant planet moves round the sun with a like period of some eleven odd years. Beyond this slight coincidence little else has been found to show any connection between the two.

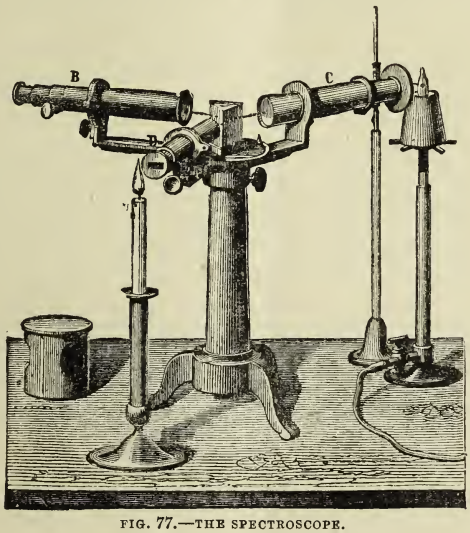
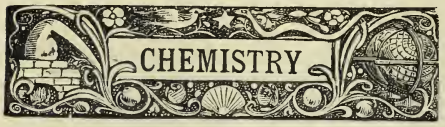


FIG. 77.—THE SPECTROSCOPE.



XXVIII.

Aluminum.

This metal occurs in large quantities, combined with other substances, as clay, marl, clay slate, slate felspar, and many other constituents of the older rocks. Metallic aluminum, obtained by the decomposition of its chloride, was formerly but little known; of late years, however, it has been prepared in considerable quantities, and, on account of its lightness and not tarnishing easily is employed in the manufacture of optical instruments, opera glasses, etc., as well as for ornamental purposes. All persons are now familiar with an alloy of this metal, termed aluminium bronze, used in making pencil-cases and other objects, and greatly resembling gold.

Compounds of aluminum met with in nature.

Uses of aluminum.

Alumina is the only oxide of aluminum known; it occurs native, combined with silica, as clay and felspar. It is also met with in a nearly pure crystalline form, as those rare and beautiful stones, the ruby and the sapphire, and also as what is termed corundum or emery. Pure alumina is a white amorphous powder. It is used in the art of dyeing to fix the colours, being what is termed a mordant. It forms insoluble compounds with the vegetal colouring matters, and renders the dye permanent, since, being insoluble, it cannot of course be washed out. Such colours are called fast colours. Although a weak base, alumina forms several salts, the best known of which are the alum series. That which is commonly termed alum is aluminum potassium sulphate, combined with twenty-four parts of water, which crystallizes in octahedra or eight-sided crystals. It will be seen, therefore, that alum is a double salt, having both aluminum and potassium for its base. We have already spoken of the uses of clay in the art of the potter, the finer kinds of porcelain being made from disintegrated felspar. This purest form of clay is perfectly free from foreign ingredients and colouring matters.

Alumina in clay.

Crystals of alumina.

Colours fixed by alumina.

Alum.

A double salt.

Purest form of clay.

The next class of metals is that known as the zinc class. Three of these, including the newly discovered metal indium, are of rare occurrence and of little practical importance; the other, however, is the well-known and valuable metal magnesium.

Zinc.

This useful metal is generally extracted from the ores known as blende and calamine, which are the sulphide and the carbonate of zinc. In the process of manufacture or reduction of the metal, the ore is broken up and roasted, or subjected to a high temperature in the presence of air, by which means it is converted into an oxide. The roasted ore is then mixed with charcoal or coal dust, and heated in retorts or crucibles; the oxygen uniting with the carbon is given off in the form of carbon monoxide, and the zinc is liberated in the metallic state. Zinc, in the form of sheets, is used for roofing, lining cisterns, and a variety of purposes for which its power of resisting elemental action or oxidation renders it specially adapted. Sheets of iron may likewise be protected from oxidation by being covered with zinc. This constitutes what is known by the somewhat unmeaning term of galvanised iron; the one metal being preserved at the expense of the other, in obedience to a well-known law of galvano-chemical action. Zinc exhibits a somewhat crystalline fracture, and is brittle at ordinary temperatures; if heated, however, to about 130° it becomes malleable, and may be hammered or rolled out into sheets. At a higher temperature it again becomes brittle. It can also be burnt in air, with the formation of an oxide. One part of zinc, combined with two of copper, forms the alloy termed brass — useful for a variety of purposes for which pure copper would be ineligible. Zinc likewise enters into the composition of bronze, gun-metal, bell-metal, etc.

Zinc ores.

Reduction of the ores.

Uses of zinc.

Galvanised iron.

Zinc rendered malleable by heat.

Containing alloys of zinc.

There is only one known oxide of zinc—the monoxide. This is a white powder soluble in the acids, and uniting with them to form the zinc salts. It forms the valuable pigment known as Chinese white or zinc white, being far more permanent than white lead. Among the more important of the other zinc salts—we have already spoken of the carbonate and the sulphide—are the sulphate and the chloride.

Zinc white.

Salts of zinc.

Magnesium.

With the oxide of this metal, magnesia, the world has long been familiar; but it is only within, comparatively speaking, recent times that the metal itself has become equally common. Magnesium, generally prepared from its chloride, is of a dull greyish-white colour. Drawn into wire or ribbon it can be kindled at the flame of an ordinary lamp or gas-burner, and burns with a brilliant white light, whose richness in the actinic or chemical rays of light renders it specially adapted for the purposes of the photographer, and is used in taking photographic views of interiors to which sunlight can have no access. Its combustion is, of course, attended with the formation of its oxide, magnesia. What is known as magnesian limestone, or dolomite, is a combination of ordinary limestone or calcium carbonate with magnesium carbonate.

Magnesia.

Combustion of magnesium.

Dolomite.

Magnesium does not oxidise in dry air, and only slowly in the presence of water. It is readily acted upon by sulphuric and hydrochloric acid, with the formation of its sulphate or chloride and the evolution of hydrogen.

Formation of the sulphate and chloride.

Magnesia, the only oxide of magnesium, is a light, white, amorphous powder, infusible in water, and slightly alkaline in its reaction. Among the more important of the salts of magnesium are the chloride, a fusible salt, and the sulphate, better known as Epsom salts—a soluble substance met with in many natural waters. Of the carbonate, existing in dolomite, we have already spoken, and it only remains for us to state that it is a white, insoluble substance, which, like the carbonate of lime, is sometimes met with in the crystalline form, and is then known as magnesite.

Salts of magnesia.

Magnesite.

Iron.

The next group of metals includes the most universal and most important, in its uses to man, of all the metals—namely, iron. Iron in an absolutely pure state can hardly be said to exist in nature, and has therefore to be prepared by the reduction of its compounds with other elements, or ores as they are termed—a most important branch of industry in this country. As the reduction of iron is attended with considerable difficulty, it is not surprising that a period should have existed in the world's history when mankind were ignorant of the existence of this metal. This is known as the "bronze age."

The iron group.

Reduction of iron.

The bronze period.

Familiar as we are with iron in the various forms of wrought and cast iron and steel, this metal, in an absolutely pure form, is seldom met with, except in the laboratory of the chemist. It may be prepared in the form of a powder by heating the oxide and exposing it to a current of hydrogen; to preserve it in this state, however, we must carefully exclude the atmospheric air. Pure iron possesses a crystalline structure, but it can be rendered tough and fibrous by the mechanical processes of rolling and heating. Although fusible at a very high degree of heat only, iron possesses the valuable property of welding at a much lower temperature,—that is to say, two distinct pieces of iron can be beaten into one homogeneous mass. Pure iron does not tarnish or oxidise in perfectly dry air unless heated to redness, when the surface quickly becomes coated with the black oxide. A small piece of iron plunged, at a white heat, into oxygen, is entirely oxidised or burnt away. The substance known as rust is the hydrate of the sesquioxide of iron; it is formed in the presence of air and water, assisted by the trace of carbonic acid almost always to be met with in both.

Absolutely pure iron.

Change of structure.

Property of welding.

Iron oxidised by heat.

Iron rust.

Many natural waters hold a greater or less portion of the hydrated oxide of iron in solution; such waters are termed chalybeate, and have a disagreeable, inky taste. When first drawn from the spring, the water holding this substance in solution is perfectly clear and colourless. On exposure to the air, however, the water soon deposits a portion of the ochreous, orange-coloured, hydrated oxide of iron. This is due to the escape of the carbonic acid from the water, whose power of holding this compound in solution is thereby diminished. Iron, at a red heat, possesses the power of decomposing water, uniting with the oxygen, and liberating the hydrogen. In enumerating the properties of iron, we must not forget to mention that it is magnetic. Any piece of iron may be magnetised by rubbing against a magnet. The magnetic force thus acquired is, however, soon lost in the case of soft iron; but a bar of steel may be thus converted into a permanent magnet. The basic oxides of iron giving rise to the salts are two in number, known as the ferrous and the ferric oxides; the latter is a sesquioxide. Among the more important of the ferrous salts are the sulphate, commonly known as green vitriol, soluble in water, and used both in dyeing and making ink. Ferrous sulphide and ferrous chloride both exist. A disulphide, FeS_2, is met with in large quantities in many parts of the world, and is used in the manufacture of sulphuric acid. It is known as iron pyrites. Ferrous carbonate, $FeCO_3$, a compound standing in the same relation to iron that chalk or limestone does to calcium, occurs largely as spathose iron ore and clay iron stone. It is from this ore that most of the iron manufactured in this country is prepared. The reduction of the metallic element from its ore is, in some cases, a tedious and elaborate process.

Iron in natural waters.

The hydrate not soluble in pure water.

Iron a magnetic body.

Steel magnets.

Ferrous salts.

Iron pyrites.

As will naturally be surmised, heat is the principal means of dissociation in every case. This in itself, however, is not always sufficient to complete the process, and we have to bring the foreign elements with which the metal is bound up in the ore into contact with something for which they have a stronger affinity than for the metal itself. A fair idea of the reduction of any of the other common metals may be gathered from a description of the method employed in the case of iron, which we have selected for illustration, as constituting, as we said, a highly important branch of industry in this country, and one to which its wealth is mainly due. Such towns as Barrow-in-Furness and Middlesborough-on-Tees may be said to owe their very existence to the iron trade developed in them by the discovery of extensive beds of the ore of this most useful metal in their vicinity.

Methods of smelting.

BOTANY.

XXX.

Classification of Plants (*continued*).

Having established the three great subsections described in the conclusion of our last article, Lindley goes on to marshal the families contained in them into groups which he aptly calls "Alliances." "Alliances" are established also among the diclines, the endogens, and the cryptogamia, thus considerably simplifying the final arrangement of the orders,—proceeding, in a word, just as in geography, after determining the continents and the countries, we have provinces or shires before going to the parishes and the towns.

Alliances.

Lastly come the Families themselves, which in both systems are much the same, only that here and there it so happens that a family contains contradictory plants, and cannot claim in either system an absolute and unexceptionable place. There is no doubt, for example, that the Ericaceæ and the Vaccinaceæ ought to stand side by side. So they do in the Candollean system. But the former have an inferior ovary, while in the heaths this part is enclosed, or superior, and hence, in the Lindleyan they are thrown far asunder. Tabulating all the exceptions and inevitable inconsistencies, each system having plenty, it would seem that there are fewer in the Lindleyan, and that their importance at the same time is less. On these grounds we strongly recommend the Lindleyan system rather than the Candollean to the student who, in arranging his specimens, or working in any way that calls for orderly arrangement of materials, wishes to follow a plan which, though far from perfect, has the merit of keeping his attention always alive to supreme principles.

Besides the exogens and the endogens proper, in the Lindleyan system there are two minor sub-classes, constituted of plants which do not quite legitimately belong to either. These are called the Dictyogens and the Rhizogens. The Dictyogens are plants in which exogenous and endogenous characters commingle— as, for example, in that lovely climber from Chili, now becoming common, called the Lapageria, also in the Paris and the Tamus, natives of our own island. The Rhizogens, on the other hand, have the complexion more of fungi than of flowering-plants, yet in the elements of their fructification are exogenous. These last, excepting one upon the shores of the Mediterranean, belong to the equatorial regions of Asia, and, being parasites, are at present unknown in cultivation. The most extraordinary of the Rhizogens is a plant called Rafflesia. It seats itself, as an epiphyte, upon the stems and branches of a species of Cissus, in the island of Java. Destitute of leaves, it presents the appearance of a huge five-lobed flower carved in a soft and spongy substance of mushroom nature, and of a rosy or tawny-pink colour. It thus very fairly gives a bound, on either side, to the highest and lowest types of vegetation, and verifies, in the best manner, the ancient rule that in nature there are no absolute lines of demarcation, while everything, on the contrary, is linked to everything else, by some curious intermediate.

Dictyogens and Rhizogens.

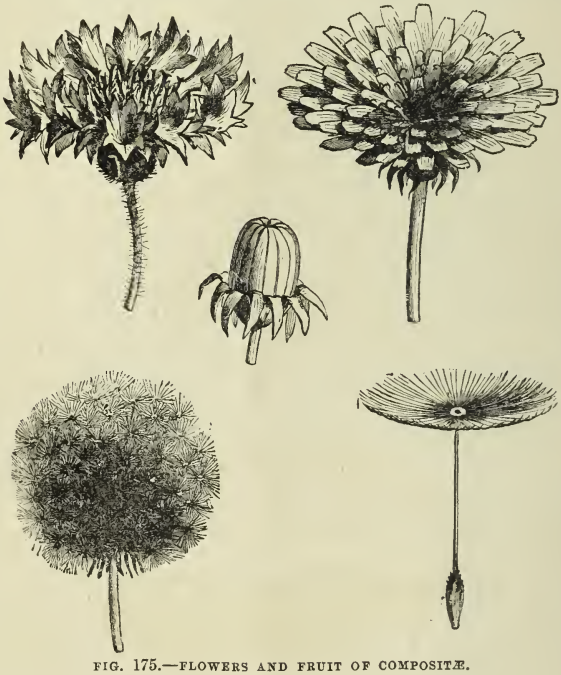


FIG. 175.—FLOWERS AND FRUIT OF COMPOSITÆ.

Thrown into the form of a chart or conspectus, so as to be seen all at one view, the substantial features of the two great systems above described, are as follow :—

Bird's-eye view.

SYSTEM I.

A. Exogens or Dicotyledones :
  * Dichlamydeæ.
    a. Thalamifloræ.
    b. Calycifloræ.
    c. Corollifloræ.
  † Monochlamydeæ.
  ‡ Achlamydeæ.

B. Endogens or Monocotyledones:
  * Petaloideæ.
  † Glumiferæ.
  ‡ Spadicifloræ.

C. Cryptogamia.

SYSTEM II.

I. Exogens.
  A. Diclines.
  B. Monoclines.
    a. Hypogynæ.
    b. Perigynæ.
    c. Epigynæ.
II. Endogens.
III. Dictyogens.
IV. Rhizogens.
V. Cryptogamia.

THE PRINCIPAL FAMILIES.

Seeing that opinions differ so widely in regard to primary classification, and as to the boundaries of genera and species, it is not surprising that botanists are not by any means yet agreed as to the precise number of the families. Dr. Lindley makes 303, which is certainly far more than needful. At the other extreme we find the authors of the "Genera Plantarum" combining many of those which are usually regarded as distinct, and which in practice it is very convenient to keep asunder. It is far less confusing to have three or four little groups, each with its own very plain, though it may be second-rate, characteristics, than to have them all called by the same name, and specialized as sub-families. A conspicuous instance of this extensive combination occurs in the Geraniaceæ of the "Genera," and another in the Saxifragaceæ. Many of the families consist of very few species. They are obliged to be kept up because those species are so very distinct in all leading particulars: in one or two instances a species stands alone in respect of structure, constituting a "family" of itself, then said to be "monotypic." The succession in which the families shall be placed in any detailed account of them depends of course upon the views taken of the great primary classes. For our present purpose, which is to give a fair general idea of practical botany, it is not desirable to mention every one of them, nor yet to follow any particular sequence. We shall take them, as nearly as possible, in the ratio of their magnitude, importance, and usefulness, distinguishing only between the exogens, the endogens, and the cryptogamia.

Number of the Families.

Pre-eminent in number of species among the exogenous families stands that one marked by "compound flowers" so called, or, more strictly, the kind of capitular inflorescence found in the daisy, the thistle, and the dandelion, as above described. There are probably about 9,000, these being diffused over the entire surface of the earth, and occupying every conceivable situation in which flowering plants can grow, two or three being inhabitants of fresh-water. The great mass of the family is herbaceous. A few species are under-shrubby, and in the southern hemisphere a few others become small trees. Every conceivable habit of growth occurs among them,—even the climbing by means of tendrils, as illustrated in the beautiful South American Mutisias. The leaves present every known and imaginable outline, from the needle-shaped up to the doubly-pinnatifid, but are never compound, and never provided with stipules. The flowers are of every imaginable colour proper to the bloom of plants, and the capitules are borne in every known form of cluster except the compound umbel. How wonderful that, with all this infinite diversity in subordinate particulars, there should still be entire agreement in just *one* particular, and ordinarily in *two* respects! For, in addition to the capitular arrangement of the florets, it happens, almost universally, that the five long anthers are conjoined into a tube. as expressed in the Linnæan term for the composites, Syngenesia. The economic value of the family is far below its variety and its magnitude. Scarcely any of the species are hurtful, but neither is there any material amount of useful service rendered. A few vegetables, such as the lettuce, the endive, the artichoke, the Jerusalem artichoke, and salsify, are found in their ranks; and some useful medicines are supplied, these last including the chamomile, the dandelion (in the shops called Taraxacum), wormwood, and other tonics and bitters. Safflower, the dried florets of the oriental Carthamus, gives a fine orange-red dye, still perceptible in the fabrics manufactured by the ancient Egyptians; and the seeds of the common sunflower are admirable food for fowls. The design of nature in the production of this beautiful order is clearly not to supply man's bodily wants. But we rejoice in the possession of it, since the grass is made lovely by

The Compositæ.

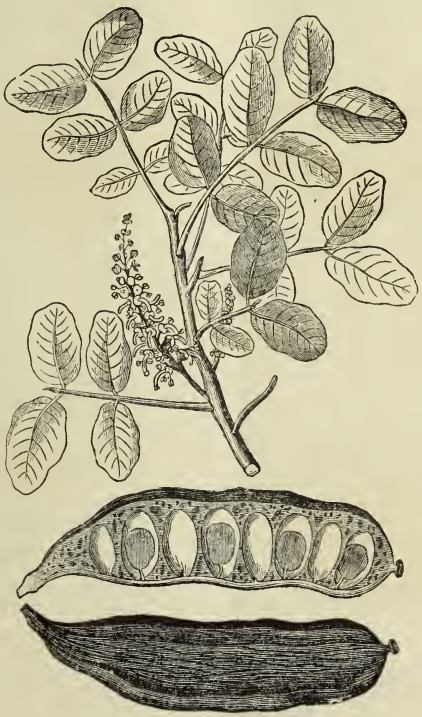


FIG. 170.—CERATONIA SILIQUA.

the daisies, and a garden shorn of its composites would, in autumn especially, be lean and bare. From June onwards, there is an unceasing flow of composite bloom; winter alone puts an end to the dahlias, the asters, the marigolds, the golden-rod, and the chrysanthemums.

The Leguminosæ.

Not much behind the Compositæ in point of numbers come the glorious plants which have flowers fashioned, more or less exactly, after the manner of the sweet-pea, and for their fruit a legume, as referred to in the name of the order, sometimes written Leguminiferæ, or the "legume-bearers." The structure of the blossoms and fruit has already been described (pp. 420, 671). It has now to be added that the leguminosæ, like the compositæ, occur in every part of the world, and in every kind of habitat, though to be aquatic is quite exceptional. In form and general appearance they are still more wonderfully diversified, large and majestic trees being frequent in warm countries, and fairly represented even in some of the foreign ornaments of our gardens and shrubberies; while of minor trees, such as the laburnum, there are again very many. In this charming order we have the richest variety of compound leaves, every form known to botanists being freely illustrated. Here, too, we find the prettiest examples of leaf-tendrils, and many of the most elegant discovered forms of stipules. The hues of the flowers, as in the composites, are beyond the counting; the varieties of the inflorescence are also endless. No two tunes in the whole compass of living nature, as regards flowers, are played with more astonishing and delightful "variations" than those which mark the pea type and the daisy type.

FIG. 177.—JERUSALEM ARTICHOKE.

XXIX.

THE VERB (*continued*).

§ 194. Lists of verbs : one form for chief parts.
§ 195. Ditto, two forms.
§ 196. Ditto, three forms.

§ 194. The following list of strong verbs is arranged for practical use in the three sets of (1) those which have only *one form* for present tense, past tense, and passive participle; (2) those which have *two forms*; and (3) those which have *three forms*. The forms here given are those now in use; a few old uses are put between brackets. But the student will remember that their rank here as strong verbs agrees with the rank of the same words in Old English, and this seems the true way of regarding them; yet, as there is no hard and fast line in the growth of language, some regard the modern form of certain verbs to be strong which historic inquiry shows are weak or contracted; hence it happens that grammarians differ considerably in the number of so-called strong verbs: taken from four standard works, they vary as 106, 170, 178, 204. The present list, therefore, will not claim to be perfect; but it aims at giving all the true strong verbs now in use. Some weak forms running side by side with the strong are put in italics.

ONE FORM

Pres.	*Past.*	*Pass. Part.*
burst	burst	burst*
set	let	let
slit	slit	slit

§ 195. TWO FORMS.

Pres.	*Past.*	*Pass. Part.*
abide	abode	abode
awake	awoke	awoke
	awaked	*awaked*
beat	beat	beaten
behold	beheld	beheld
bind	bound	bounden, bound
cling	clung	clung
climb	clomb	*climbed*
	climbed	
come	came	come
fight	fought	foughten, fought
find	found	found
fling	flung	flung
forget	forgot	forgot, forgotten
get	got	got, gotten
grind	ground	ground
help	*helped*	holpen, *helped*
hold	held	held, holden
knot	knit	knit
lose	*lost*	lorn, *lost*
make	made	made
run	ran	run
shape	shaped	shapen
shine	shone	shone
shoot	shot	shot
sit	sat	sat
slide	slid	slid, slidden
sling	slung	slung
slink	slunk	slunk
stand	stood	stood
sting	stung	stung
string	strung	strung
swing	swung	swung
win	won	won
wind	wound	wound
wring	wrung	wrung

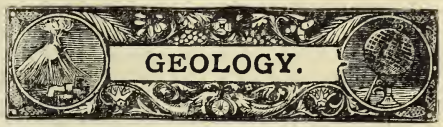
§ 196. THREE FORMS.

Pres.	*Past.*	*Pass. Part.*
arise	arose	arisen
bake	*baked*	[baken] *baked*
bear (bring forth)	bore, bare	born
bear (carry)	bore, bare	borne
begin	began	begun
bid	bade, bid	bidden
bite	bit	bitten, bit

* See *burst* in Div. I. cl. ii. p. 84

Pres.	*Past.*	*Pass. Part.*
blow	blew	blown
break	broke, brake	broken
chide	chid [chode]	chidden, chid
choose	chose	chosen
cleave (split)	clove, cleft	cloven, cleft
cleave (cling	clave	cleaved
cling [to)	clang	clung
crow	crew	[crown]
	crowed	*crowed*
do	did	done
draw	drew	drawn
drink	drank	drunk
drive	drove [drave]	driven
eat	ate	eaten
fall	fell	fallen
fly	flew	flown
forbear	forbore	forborne
forsake	forsook	forsaken
freeze	froze	frozen [frore,
give	gave	given [frorn]
go	went*	gone
grave	*graved*	graven
grow	grew	grown
hang	hung	hung
	hanged	*hanged*
heave	hove, *heaved*	*heaved*
hew	*hewed*	hewn
know	knew	known
lade, load	*laded*	laden, loaden
lie	lay	lain
melt	*melted*	molten, *melted*
mow	*mowed*	mown
ride	rode	ridden, rid
ring	rang, rung	rung
rise	rose	risen
rive	*rived*	riven
see	saw	seen
seethe	sod	sodden
	seethed	*seethed*
shake	shook	shaken
shave	*shaved*	shaven
shear	*sheared*, shore	shorn, *sheared*
shrink	shrank	shrunken
sing	sang	sung
sink	sank	sunken, sunk
slay	slew	slain
smite	smote	smitten
sow	*sowed*	sown, *sowed*
speak	spoke [spake]	spoken
spin	spun, span	spun
spring	sprang	sprung
steal	stole	stolen
stink	stank	stunk
stride	strode	stridden
strike	struck	stricken, struck
strive	strove	striven
swear	swore	sworn
swell	*swelled*	swollen
swim	swam	swum
take	took	taken
tear	tore, tare	torn
thrive	throve	thriven
throw	threw	thrown
tread	trod	trodden
wake	woke, *waked*	woke, *waked*
wax	[wox] *waxed*	waxen
wear	wore	worn
weave	wove	woven
write	wrote	written

* We have lost the old past tense of *go*; *went*, which takes its place, is the past tense of an old verb *wendan*, to go or to turn.



XXIV.

Tertiary Period (*continued*).

It is in the Pleistocene river gravels and brick earths that we obtain the earliest indications in this country of man. Rough, unpolished instruments, usually made of flint, where flint was to be had, occur in considerable numbers. It would be easy to conjecture that the men who made and used these implements were mere hunters, knowing nothing of agriculture, and wearing the skins of the animals slain for food; but, after all, it would be little better than conjecture, seeing that we really know nothing more than that these rude implements—many of them, however, much more skilfully chipped than appears at first sight and to an untrained eye—are unmistakable evidence that before the gravels in which they are now found, human beings inhabited the country, and that either for a long time or in considerable numbers.

First appearance of man in Britain.

The question whether man existed in this country before the glacial period set in cannot yet be answered. It is possible, but it has not yet been demonstrated. It should, however, be remembered that, upon any theory whatever, man was an immigrant into Great Britain. The human race certainly did not originate here. Whenever he appeared in this country, earlier or later, he came as a stranger,—probably from the far East,—and it is eastward that we must turn for the earliest traces of the human family. The fact that we can carry back the evidence of man's existence in this country to a period so far remote as the time when the gravels and brick earths of the Thames valley, for instance, were laid down, is very impressive, and evidence enough that the older systems of chronology require revision and correction.

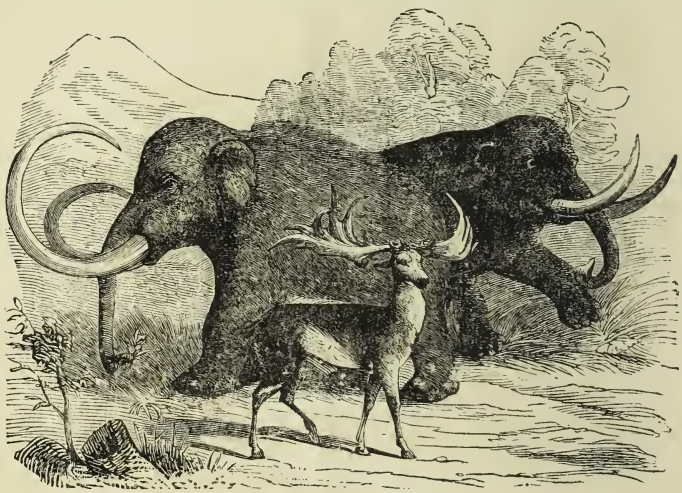
The testimony of the implements found in the river gravels as to the antiquity of man has been confirmed by the exploration of the caverns which are common in most limestone rocks, and which, both in this country and on the Continent, have often served as the dwelling-places of earlier and ruder peoples. We cannot give the details of these investigations here, as they would occupy more space than we have at command. It will be enough to state their general nature and the conclusions to which they have led. In England, amongst the more important caverns explored are Kent's Hole and Brixham Cavern, both in Devonshire;

The early cave dwellers.

Wookey Hole, Somersetshire; Church Hole and Robin Hood Cave, Creswell Crags, Derbyshire; and the Long Hole and other caves, Gower, Glamorganshire, etc., etc. In all these the traces of human occupation, or implements fashioned by human hands, have been discovered under such circumstance, and in such association with the remains of animals either entirely or locally extinct, as to show that man was contemporaneous with them, and that all date back to a very remote antiquity.

Their habits, as shown by implements, tools. etc.

The further conclusion has been reached, with some degree of certainty, that at least two races of men inhabited Great Britain in Pleistocene times: the earlier being the men of the "river drift" period, of whom, as already stated, we know nothing excepting that they lived here; and the other the cave-dwellers, of whose habits we have some important evidence. Kent's Hole has yielded, besides flint implements, bone harpoons, a bone needle, and a bone awl or piercer, not in the superficial layers of the cave earth, but low down with the oldest implements. These, with other finds elsewhere, leave no doubt that the cave men were both hunters and fishers, and wore garments made of the skins of animals, which they probably sewed together with a thread made of sinew, as the Esquimaux of modern times either do now or did until recently.



MAMMOTH AND IRISH ELK.

Engravings in bone, etc.

An exceedingly interesting discovery made in the Robin Hood cave, during its exploration by Mr. Boyd Dawkins and the Rev. J. M. Mello, gives us another and an important clue to the habits of these ancient people. Great Britain, both in the early, and certainly during a part of the later, Pleistocene period, formed part of the Continent; and on the Continent, especially in the caves of the south of France, the bone and stone weapons and tools of a very ancient people have been found in great abundance. Like the Esquimaux, they appear to have had a considerable amount of artistic skill, and, as the Esquimaux do, they ornamented their bone implements, etc., by engraving them. In some cases this engraving is very striking, in others it is more interesting, perhaps, than artistic; but in most cases the skill with which it is executed is surprising. These engravings tell us in their own way a good deal about the habits of the people themselves. In some of them are figured the long skin gloves which protected their hands and arms from the cold; in others we have hunting scenes—one in which the great urus is being stalked; the mammoth, the reindeer, bison, wild horse, the great cave bear, seal, whale, and birds and fish of various kinds, have been with greater or less success thus represented. The attempts to portray the human figure are far less successful, and in some cases it would almost be necessary to write underneath "This is a man," to make it possible, at first sight, to recognise the artist's idea.

The discovery made in the Robin Hood cave, to which we referred above, was a similar drawing of the head of a horse sketched on a rib bone. It is the only engraving of the kind that has yet been found in England, and its occurrence with the implements of the early cave-dwellers may be taken as a pretty clear indication that both in what are now England and France these early inhabitants were of the same race and approximately of the same period.

Agriculture probably unknown.

There is nothing to tell us that these early men cultivated the soil. Fire, we know they had; but no pottery has yet been discovered which it is safe to refer to those long past times; nor do we find any traces of domestic animals—horse, dog, ox, or sheep. They were cave-dwellers, hunters, fishers, and fowlers; but what sort of men they were physically we do not know. Human remains of very early date have been discovered both here and on the Continent, but none that can be absolutely identified with the races of which we have been speaking.

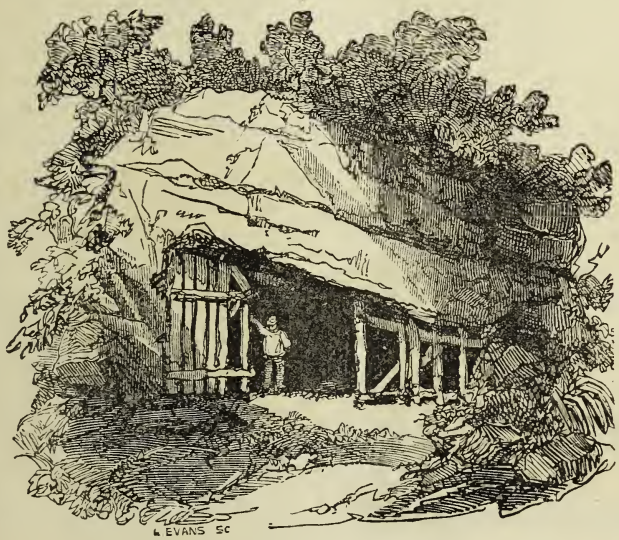
It is right to say that these discoveries have from time to time given rise to many discussions. It was at first asserted that the flint flakes and chipped implements which were found in the gravels and elsewhere were only stones naturally fractured, and subsequently the antiquity of the implements was persistently denied by those to whom the conclusion that man had

been an inhabitant of Europe so many ages ago seemed incredible. Both points may now be considered practically settled. No one having any acquaintance with the subject will fail to recognize the artificial shape of the flint and chert implements; and few people, indeed, now cling to the ideas formerly entertained as to the time during which the human race has been upon the earth.

When the discovery was made that there had been a glacial period, the question What was the cause of it? naturally occurred, and the answer was not very readily forthcoming. If the traces of that long cold period had been confined to our own islands, we might have imagined it to be the result of local causes, but it is not so. Through the whole of northern Europe, and in North America, evidences of ice action similar to those which occur in this country are to be found; and in searching for a cause, we have to look for one adequate to the extent of lowering the temperature of the whole hemisphere. In the judgment of most geologists the primary cause of the glacial epoch was astronomical. The orbit of the earth round the sun is not circular, but elliptical, and the eccentricity of the ellipse varies largely, slowly, and irregularly. There are also other astronomical movements which affect the climates of the hemispheres, and to which it is believed the existing differences between the amount of ice in the land surrounding the North and South Poles respectively is partially due. To these causes, but principally to an increased eccentricity of the earth's orbit enhanced by minor geographical changes, it is believed the glacial epoch was due,—amongst the most important of these latter being the elevation of the land.

The cause of the glacial epoch probably astronomical.

Eccentricity of the earth's orbit.



KENT'S CAVERN, NEAR TORQUAY.

We have had occasion to remark more than once that no calculations based upon the rate at which denudation or the deposit of new strata is carried on can be from the nature of things entirely satisfactory, because it is very difficult to get anything like reliable data, since they may vary from age to age according to circumstances which we have no means of estimating with sufficient precision. It is altogether different when we have to deal with astronomical movements: these can be calculated with exactness, and hence, for the first time in geological history, we find ourselves able to measure the interval over which given phenomena lasted.

Date of the glacial period.

Dr. Croll, to whom the world is indebted for his elaborate investigations into this subject, has given tables which show that fifty thousand years ago the eccentricity of the earth's orbit was much less than it is now; from that period *reckoning backwards*, it increases until one hundred thousand years since there was a difference of 8,500,000 miles between the distance of the earth from the sun at the nearest and the most distant points of its orbit. Fifty thousand years before that the difference was less—about six millions of miles; and two hundred and ten thousand years ago there was a difference of no less than ten and a half millions of miles.

Dr. Croll's tables.

To estimate the full effect of these variations would be manifestly very difficult, but it would appear that the commencement of the glacial period was about two hundred and forty thousand years ago; that the cold was most severe about two hundred thousand years since; that then through long course of time it became gradually first milder, then colder, then milder, and finally terminated about eighty thousand years ago.

The conclusions drawn from astronomical calculation, are not contradicted by observed facts. The broad features of the glacial period, as represented by the boulder-clays, drifts, and other deposits, are, as we have seen, a period of elevation and a climate of arctic severity; a middle period of depression and more temperate conditions; then, first a further increase of cold, and afterwards a gradual modification of climate, which ended in a return to what we may perhaps be permitted to call the normal state of things.

These calculations not contradicted by observed facts

We have already seen that in the early Pleistocene period, represented by the Norfolk Forest Bed and its fauna, there was nothing to suggest anything but a temperate climate. When, however, we come to deal with the

mammalia of middle and later Pleistocene times, there is a mixture of southern and northern forms which can only be accounted for by considerable seasonal and other climatal changes. Amongst the animal remains we find those of the lion, hyæna, the hippopotamus, and the Caffre cat; as a contrast to these we have also the pouched marmot, the lemming, tailless hare, glutton, musk sheep, and the reindeer. We have besides the beaver, hare, rabbit, wild cat, marten, stoat, weasel, otter, two species of bear, wolf, fox, horse, urus, bisón, antelope, wild boar, stag, and roe. These, it will be observed, are all living species. There were, besides, the leopard, which is no longer an inhabitant of Great Britain; the mammoth, which was a large hairy elephant with curved tusks, is entirely extinct, as is the *Elephas antiquus*; three species of rhinoceros, and all extinct; the cave bear and the Irish elk are also extinct.

Mammalian Pleistocene period.

Even in glacial times summer and winter came in regular succession, and, as now in Siberia and North America the rigors of a severe winter will drive the northern animals southward, so in older times the heats of summer and the severity of the cold winters would drive the animals north and south as occasion demanded.

It would be interesting to learn how far the human kind of those far-off times shared in these migrations. They too have disappeared; and we do not know whether they have left any descendants or representatives. The conjecture has been hazarded that the Esquimaux of Greenland are probably of the same race. It may be so; but the evidence is not very strong.

Disappearance of Pleistocene man.

GERMAN.

XXXI.

STUDY FOR READING AND PRONUNCIATION.

Der große Hund.[1]
dare grow-se hunt
THE GREAT DOG.

Unten in der Wirthsstube[2] einer kleinen
un'-ten in dare veerts'-stoo-be i'-ner kly'-nen
Below in the inn-room of a little

Stadt saß der Bären-führer[3] und aß sein
statt zahs dare bair'-en-fue-rer unt ahss zyne
town sat the bear-leader and ate his

Abendbrod. Der Bär stand draußen[4]
ah'-bend-broht dare bearr stand drowss'-en
supper. The bear stood outside

an den Holz-stall angebunden; der arme
an dane holts-stall an'-ge-bun-den dare arr'-me
by the wood-stable tied up; the poor

Bär, der Niemand[5] etwas zu Leide that,
bearr dare nee'-mant et'-vas tsoo ly'-de taht
bear, who nobody something to injury did,

obgleich er grimmig genug aussah.[6]
op-glych' airr grim'-mich ge-nooch owss'-zah
although he grim enough looked.

Oben in der Dachkammer[7] spielten bei
oh'-ben in dare dach'-kam-mer speel'-ten by
Up in the attic played by

Mondenschein drei kleine Kinder; das
mohn'-den-shine dry kly'-ne kin'-derr dass
moonshine three little children; the

älteste war höchstens[8] sechs Jahre alt,
el'-tes-te vahr hoech'-stens zex yah'-re alt
eldest was at most six years old,

das jüngste nicht mehr als zwei.
dass yueng'-ste nicht mairr als tsvy
the youngest not more than two.

Klitsch, klatsch! kam es die Treppe[9] herauf;
klitsh klatsh kahm es dee trep'-pe her-owff
Klitch, klatch! came it the stairs up;

wer konnte das sein? Die Thür flog auf,
vairr konn'-te dass zyne dee tuer flohg owff
who could that be? The door flew open,

es war der Bär, der zottige Bär.
es vahr dare bearr dairr tsot'-tich-e bearr
it was the bear, the shaggy bear.

Es war ihm langweilig[10] geworden, im
es vahr eem lang'-vi-lich ge-vorr'-den im
It was to him tedious become in

Hofe zu stehen, und er hatte den
ho'-fe tsoo stay'-en unt airr hat'-te dane
the yard to stand, and he had the

Weg die Treppe hinauf gefunden. Die
vaych dee trep'-pe hin-owff ge-fund'-en dee
way the stairs up found. The

Kinder waren so erschrocken[11] über das
kin'-derr vah'-ren zo er-shrok'-ken ue'-berr dass
children were so frightened at the

große zottige Thier, daß jedes in eine
grow-se tsot'-tich'e teer dass yay'-des in i'-ne
great shaggy beast, that each into a

Ecke kroch;[12] aber er fand sie alle
ek'-ke kroch ah'-berr airr fand zee al'-le
corner crept; but he found them all

drei, beschnüffelte sie, that[13] ihnen
dry be-shnuef'-fel-te zee taht ee'-nen
three, besnuffled them, did to them

aber nichts.
ah'-berr nichts
however nothing.

„Das ist sicher[14] ein großer Hund,"
dass ist zich'-er ine grow'-ser hunt
"That is certainly a great dog,"

sagten sie, und streichelten ihn. Er
zaach'-ten zee unt stry'-chel-ten een airr
said they, and stroked him. He

legte sich auf den Boden.[15] Der
laych'-te zich owff dane bo'-den dare
laid himself on the floor. The

kleinste Knabe wälzte[16] sich über ihn
kline'-ste knah'-be velts'-te zich ue'-berr een
smallest boy rolled himself over him

und spielte, indem er seinen blonden[17]
unt speel'-te in-dame' airr zy'-nen blon'-den
and played, in that he his fair

Lockenkopf in dem dichten schwarzen
lock'-en-kopf in dame dich'-ten shvarz'-sen
curly head in the thick black

Pelz des Bären verbarg.[18] Nun holte
pelts des bearr'-en fer-barg' noon hole'-te
fur of the bear hid. Now brought
der älteste Knabe eine Trommel und
dare el'-te-ste knah'-be i'-ne trom'-mel unt
the eldest boy a drum and
schlug darauf, daß es dröhnte,[19] und der
shlooch dah'-rowf dass es droen'-te unt dare
beat thereon, that it sounded, and the
Bär erhob sich auf seine Hinterbeine
bear er-hope' zich owff zy'-ne hin'-ter-by'-ne
bear raised himself on his hind-legs
und begann zu tanzen; das war
unt be-gann' tsoo tan'-zen dass vahr
and began to dance; that was
allerliebst![20] Jeder von den Knaben
aller-leebst' yay'-derr fon dane knah'-ben
most charming! Each of the boys
nahm ein Gewehr,[21] dem Bären gaben
nahm ine ge-vairr' dame bear'-en gah'-ben
took a gun, to the bear gave
sie auch eins, und richtig,[22] er hielt es
zee owch eince unt rich'-tich airr heelt es
they also one, and surely he held it
fest. Es war ein prächtiger[23] Kamerad,
fest es vahr ine prech'-ti-cher kah-me-raht'
fast. It was a famous comrade
den sie bekommen[24] hatten, und nun
dane zee be-kom'-men hat'-ten unt noon
whom they received had, and now
marschirten sie: eins, zwei; eins, zwei!
mar-sheer'-ten zee eince tsvy eince tsvy
marched they; one, two; one, two!
Da faßte Jemand an die Thür; sie
dah fass'-te yay'-mant an dee tuer zee
Then grasped some one at the door; it
ging auf; es war die Mutter der Kinder.
ging owff es vahr dee mut'-ter dare kin'-der
went open; it was the mother of the children.
Ihr hättet sie sehen sollen, sprachlos
eer het'-tet zee zay'-en zol'-len sprach'-lohs
You should her seen have speechless
vor Schrecken, mit todtenblassem Gesicht,
fore shrek'-en mit tow'-tem-blas'-sen ge-zicht'
for fright, with deathly-pale face,
halboffenem Munde und stieren[25] Augen![26]
halb-of'-fe-nem moon'-de unt stee'-ren ow'-gen
half open mouth and staring eyes!
Aber der kleinste Knabe nickte so
ah'-berr dare kline'-ste knah'-be nick'-te zo
But the smallest boy nodded so
vergnügt und rief laut in seiner Sprache:
fer-gnuecht' unt reef lout in zy'-ner sprah'-che
joyously, and called loud in his language:
„Wir spielen nur Soldaten?"[27] Und dann
veerr spee'-len noor zol-dah'-ten unt dann
"We play only (at) soldiers. And then
kam der Bären-führer.
kahm dare bear'-en-fue'-rer
came the bear-leader.

H. C. ANDERSEN.

REMARKS ON THE FOREGOING STUDY.

[1] The true incident here related is told by Hans Christian Andersen among the sketches in his "Stories and Tales," under the title "What the moon saw."

[2] *Die Wirths-stube*, from *der Wirth*, the host; and
dee veerts'-stoo-be dare veert
die Stube, the room (literally the host's room).
dee stoobe

[3] *Der Bären-führer*, from *der Bär*, and *führen*, to lead.
dare bair'-en-fue'-rer dare bair fue'-ren

[4] *Drauszen* is an abbreviation of *da*, there; and
drowss'-en
auszen, outside. In the same way *drinnen* (*da innen*)
drin'-nen
signifies within; *droben* (*da oben*), above; *drunten*
dro'-ben drun'-ten
(*da unten*), below; *drüben*, over yonder, etc.
drue'-ben

[5] *Niemand*, the Latin *nemo*, the opposite to *Jemand*,
nee'-mant yay'-mant
somebody.

[6] *Aus-sah*, from *aus-sehen*, to appear (present an
owss'-zah owss'-zayen
appearance). *Ich sehe aus*, I appear; *ich sah aus*, I
ich zay'-e ouss ich zah ouss
appeared; *ausgesehen* (p. part.), appeared.
ouss'-ge-zay-en

[7] *Die Dach-Kammer*, the attic (from *das Dach*, the
dee dach'-kam-mer dass dach
roof, and *die Kammer*, the chamber); literally the roof
chamber. Notice that the compound word takes the
gender of the last of its constituents; here neuter,
because *Kammer* is neuter.

[8] *Höchstens*, a superlative form (from *hoch*, *höher*,
hoech'-stens hoach hoe'-er
höchst, high, higher, highest. The *ens* is like the
hoechst
English "at": *wenigst*, least; *wenigstens*, at least.
vay'-nichst

[9] *Die Treppe*, the flight of stairs, the staircase (from
dee trep'-pe
the Greek *trappa*); hence the geological term, "trap
porphyry," etc.

[10] *Langweilig*, tedious (from *lang*, long, and *Weile*,
lang'-vi-lich lang vy'-le
while or time). The German noun, *die Langweil*, is
equivalent to the French *ennui*; and the reflective
verb, *sich lang-weilen*, is to suffer from *ennui* or boredom,
sich lang'-vi-len
s'ennuyer.

[11] *Der Schreck*, the fright; *ich erschrecke*, I am fright-
dare shrek ich er-shrek'-ke
ened, startled (imp. *erschrak*, p. part. *erschrocken*).
er-shrahk er-shrok-ken

[12] *Kroch*, crept, from the verb *kriechen*, to creep
kroch kree'-chen
(imp. *ich kroch*, I crept; past part. *gekrochen*, crept).
ich kroch ge-kroch'en

[N.B.—It is advisable to commit to memory these forms of irregular verbs when they occur, as they will be frequently met with, and the verbs themselves will be spoken of further on.]

[13] *That*, did, the imperfect of *thun*, to do; *Ich thue*,
taht toon ich too'-e
I do; *Ich that*, I did; *gethan*, done.
ich taht ge-tahn

[14] *Sicher* is here an adverb; it is also used as an
zich'-er
adjective: thus, *Der sichere Weg*, the safe way. Note
dare zi'-cher-e vaych
that adjectives in German are used as adverbs, without change of form. *Das Haus ist sicher*, the house is
dass house ist zich'-er
safe; *Wir gehen sicher*, we go safely or securely.
veer gay-en zich'-er

[15] *Der Boden*, the floor. The word *Boden* is also
dare boh'-den
applied to the store-room built under the roof in German houses; thus, *der Korn-boden* is the granary
dare korrn'-boh'-den
or store-room for corn.

[16] *Die Walze*, the cylinder or roller; hence *sich*
dee vall'-tse zich
wälzen, to roll oneself (turn like a roller).
vell'-tsen

[17] *Blond* is fair or light, as applied to hair; thus
blonnd
blond-lockig and *schwarz-lockig*, with fair locks and
blonnd'-lockich shvarts'-lockich
dark locks.

[18] *Verbergen*, to hide (imp. *Ich verbarg*, past part.
fer-bairr'-gen ich fer-barg'
verborgen), hidden, concealed.
ferr-borr'-gen

[19] *Dröhnen*, to emit a *droning* sound, the *drone* of a
droen'-en
bagpipe (past p. *gedröhnt*).
ge-droent'

[20] *Allerliebst*, most charming; a strong superlative,
aller-leebst
from *liebst*, most lovely; and *aller*, of all—thus *der*
leebst al'-ler dare
aller klügste Mann, the cleverest man (of all men).
all'-er klueg'-ste mann

[21] *Das Gewehr*, originally meant a weapon (from
dass ge-vairr'
wehren, to defend); it is now only used for a firearm—
vairr'-en
"*Schultert's Gewehr!*" "Shoulder arms!"
shull'-terts ge-vairr'

[22] The expression *richtig* is equivalent to the English
rich'-tich
"sure enough."

[23] *Prächtig*, literally splendid (from *die Pracht*,
prech'-tich
splendour).

[24] *Bekommen*, to obtain, to receive as a present (imp.
be-kohm'-en
ich bekam, p. p. *bekommen*).
ich be-kahm' be-kom'-men.

[25] *Stier* is here an adjective, staring. There is also
steer
a verb *stieren* (imp. *ich stierte*, p. part. *gestiert*).
steer'-en ich steer'-te ge-steert'

[26] Notice the dative case after *mit*—singular in *em*,
plural in *en*.

[27] The English *at* is not here expressed; for instance,
Ball spielen, to play *at* ball.
bahll spee'-len

Exercise on the Foregoing Study.

To be translated into German, and then corrected by the German version given below.

A bear-leader was eating (ate) his supper. His bear stood outside, tied up. In the attic three little children played. The youngest was not more than two years old.

The door flew open. It was the bear. He had found the way up the stairs. The children were frightened, and each crept into a corner. But the bear did nothing to them.

Then they said: "That is certainly a great dog." They stroked him; and one of them brought a drum, and beat thereupon. The bear raised himself on his hind-legs and began to dance. Each of the boys took a gun, and they gave the bear one, and all marched, "one, two, one, two," and the bear held his gun fast, and marched also. It was splendid.

Suddenly (plötzlich) went the door open, and the mother of the children stood there. She was deadly pale and speechless with (for) terror; but the smallest boy nodded his (with the) head, quite pleased, and said: We are playing at (play) soldiers;—and then came the bear-leader, and the bear was taken away. And this is a true story.

XXVII.

Egypt (*continued*).

The king who succeeded Shofra, named Menkaura, or Mencheres, emulating his immediate predecessors, erected a third pyramid near the others. He appears to have been desirous to restore the worship of Osiris, which in the preceding reigns had been neglected in favour of the homage paid to other divinities. The sarcophagus of this monarch and the inner coffin of cedar wood containing his remains have been discovered by modern explorers, who found also that at some remote period the coffin had been opened and the body deprived of its ornaments. Not even a pyramid could afford security against sacrilegious robbers. The inscription on the coffin, an extract from a ritual of worship prepared about this time, refers distinctly to the legendary story of Osiris, whose name was appropriated to the dead king. Dr. Birch remarks that "the coffin of Menkaura marks a new religious development in the history of Egypt."

A pious king.

Menkaura reigned sixty-three years, and under his rule the country appears to have enjoyed peace and prosperity. Agriculture was encouraged and the arts were developed. Really remarkable artistic power is exhibited in some of the memorial sculptures of this period. The hard granite of Syene and the softer alabaster were employed, and worked with great delicacy and precision, and the proportions of the human form were observed. Wood, too, was used in statuary. Dr. Birch says of one wooden statue of this period preserved in the museum of Boulak, near Cairo, "It is an unrivalled work of ancient art, representing a person of high rank of an age after the meridian of life, with a truth, grace, and fidelity, which show the hand of a great master. The limbs are detached, the eyes inlaid, and in its lifelike treatment the experienced eye beholds the unchanging type of the inhabitant of the valley of the Nile."

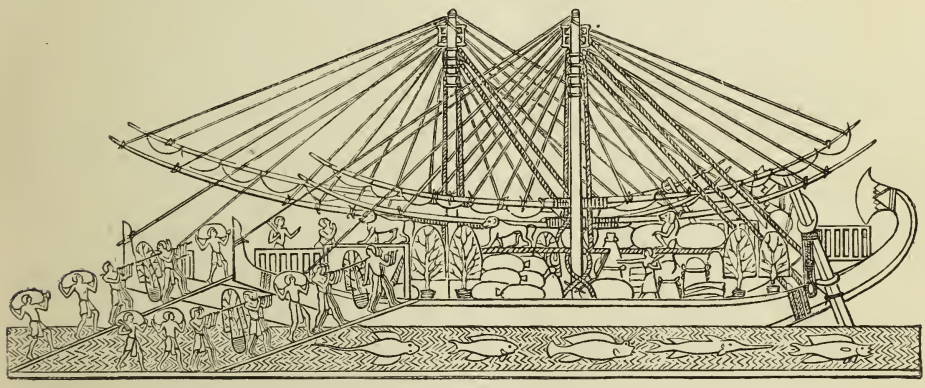
Artistic sculpture.

The only other monarch of the fourth dynasty of whom any record is preserved is Aseskaf, probably the Asychis of Herodotus. He reigned twenty-five years, but no public events of importance are mentioned in the inscriptions or depicted in the pictures, the light red, blue and yellow colours of which are still visible. The country appears to have been in a prosperous condition, so far at least as the upper classes of Memphian society were concerned. It was not the habit of ancient chroniclers, either literary or pictorial, to trouble themselves much about the humble "hewers of wood and drawers of water." They toiled, suffered, and died in obscurity; but the priests of the great temple, the lordly owners of the land, lived in splendour, and the sculptures and pictorial representations afford us glimpses of the official and domestic life of these grand personages of Lower Egypt. We see them, surrounded by warriors and slaves, as the rulers of provinces and high dignitaries of the palace. The king was the object of worship, deified almost in his lifetime; and the priestly offices, to which considerable emoluments were attached, were distributed chiefly among members of the royal family. One fortunate youth, Ptahases, married the princess Matsha, daughter of King

Egyptian artists.

Asekaf, and, we read, "was invested with the post of secretary of the board of works [a very modernized description of the official post], and the king allowed him to go into the royal palace without prostrating himself in the presence of the monarch." This was no doubt a great privilege; and the fact that it was thought worthy of special record shows the intense reverence for the royal person, amounting, indeed, almost to a belief that the king was a descendant or representative of the gods. The nobles employed themselves in visiting their estates, superintending agricultural operations, boating on the Nile, hunting, listening to the music of harpers, or watching the performances of dancers and tumblers. Their houses were handsomely built, and well furnished; their dresses were of white linen, and they wore golden ornaments and wreaths of flowers on their heads. There was no subjection of the female sex, as in most oriental countries; on the contrary, the ladies enjoyed a full share of public display and private pleasure. The religion of the people, theoretically very complex as far as the worship of many gods was concerned, was practically a code of moral laws, justice, kindness, and the performance of works of charity. Good works were the passport to happiness in the unknown world beyond the grave. The aristocratic and wealthy Egyptians, Dr. Birch tells us, "enjoyed all the pleasures of existence, and delighted more in the arts of peace than war." This might pass for the description of a golden age of Egyptian history; but there was very probably a dark background which the painters did not choose to depict, and which the writers of monumental inscriptions perhaps were not permitted to record in hieroglyphics.

Domestic life.



LOADING AN EGYPTIAN SHIP.

We can but surmise the causes which led to another change of dynasty. Luxury may have weakened the sinews of the state; the splendour and wealth of the great Memphite kingdoms of Lower Egypt may have excited the envy of the rulers of the Theban and Elephantine kingdoms of the upper Nile. The fifth dynasty is described as composed of huge blocks of limestone, at Sakkarah. It still exists, and is known as Mastabat-el-Faroum, "the board (or table) of Pharaoh." In the time of these kings further mining operations were undertaken in the Sinaitic peninsula, and, if we may judge from the many magnificent sepulchres in the vicinity of Memphis, the country was wealthy and prosperous. The kings themselves built pyramids for the reception of their bodies, and divine honours were paid to them after death. Whatever the theology as taught by the Egyptian priests of this time may have been, a high moral tone seems to have pervaded the practical religion of the community. The oldest extant manuscript of the world, probably the oldest literary composition in the world—earlier in date than the book of Job, even if we adopt the most remote date assigned by any Biblical critic—older than the most antique Babylonian inscriptions on baked clay—is a collection of moral precepts, written on papyrus in the hieratic or priestly character, and still preserved,

A new dynasty.

Religion and morality.

known to Egyptologists as the Prisse papyrus, from the name of its possessor. It appears to have been written at some time of the period of the fifth dynasty, considerably more than two thousand years before the Christian era. The author describes himself as Ptahhetp, the son of a king, and as having reached the age of 110 years, "one of the ancients of the earth." The book is addressed to his son; and, says Dr. Birch, "the language calls to mind the Wisdom of Solomon." The son is urged to pass through the years of his life without falsehood; "a good son is the gift of God," "the son who accepts the words of his father will grow old on account of it." We might almost accept this as a quotation from Solomon's Proverbs: "Good words shine more than the emerald which the hand of the slave finds on the pebbles;" and there is a foreshadowing of the later and higher teaching in "Let thy heart wash away the impurity of thy mouth."

The sixth dynasty was probably brought about by a popular movement which replaced on the throne kings of the old Memphite race. A military spirit appears to have been aroused, for the monuments connected with this dynasty extend up the banks of the Nile into Middle Egypt, indicating an extension of territory southwards; and the supposition is strengthened by the fact that the first monarch of the line, Teta, or Orthoes, was murdered by the soldiers of his guard, after a reign of thirty years. There are records, on a tomb at Sakkarah, of expeditions up the Nile, undertaken by the king. A very long reign followed—that of Pepi, or Phiops, who, according to the lists delivered to the Greek historians, wore the crown for a hundred years; but the monuments, although recording a long period, considerably limit that computation. The old peaceful times had passed away, and warlike tendencies were developed. We obtain glimpses of the career of one of those energetic men, politicians as well as warriors, who imprint their personality on the history of a nation. Una, who as a youth held the office of crown-bearer to King Teta, and was of priestly rank and probably of royal race, was entrusted with the important office of superintendent of the storehouses, and obtaining the favour of the new king, Pepi, became chief of the coffer or royal treasury—chief minister, in fact, and like the Joseph of a later time, the administrator of the resources and wealth of the kingdom. He was entrusted with the honourable and important mission of preparing the pyramid which the king, in accordance with the custom of his predecessors, was arranging for his own interment, and was promoted to the high dignity, accompanied with large emoluments, of priest of the royal pyramid. The place where it was erected is described as "the land of Ruah, in the south"; and that the mission was attended with some peril appears to be indicated by the mention of a troop of warriors accompanying Una.

The sixth dynasty.

A great statesman and general.

The Arab tribes known as the Aa, or Aamu, in whom we may perhaps recognize the inhabitants of the Sinaitic peninsula, or those of the districts beyond, extending into the north of the country now known as Arabia, seem to have troubled the Egyptians about this time; or it may be that the promise of great mineral treasures in the country afforded by the mines at Wady Magarah, suggested an invasion in force and an attempt to conquer the country. Other enemies were found in the Herusha, "those in the sands," who may have been the nomades occupying the country between the valley of the Nile and the Red Sea, or even of the opposite coast. Una, the successful minister, the most powerful man attached to the Egyptian court, became a military leader, and adopted a remarkable plan of augmenting the forces at his disposal. He formed an army of negroes, most likely slaves captured in the lands adjoining Nubia—a fact which shows that the Memphite kingdom was at this time practically supreme along the whole valley of the Nile—officered them with Egyptian warriors, some of them members of the high-priestly caste, and then at the head of his dusky legions, the first negroes of whom there is any record in history, marched into the country of the Herusha, ravaging and slaughtering, and making many captives. The inscriptions show that the expedition was made by water, but whether only on the Nile or the more extensive waters of the Red Sea, cannot be determined. Una returned in triumph; but hearing that the Herusha had rallied their strength and were again defiant, he re-embarked and inflicted on them a crushing defeat. The life of this able and enterprising man, the earliest historical representative of the class of statesmen-warriors who have been the real rulers of states, extended into the reign of the successor of Pepi—a fact which clearly proves that the statement of the priestly chroniclers who assigned a duration of a century to the reign of that king must have been very greatly exaggerated. Una was in high office in the time of Teta, and after the death of Pepi (throughout whose reign he was in active employment), was appointed by Merienra, his son and successor, governor of an extensive territory south of Elephantine, and was employed on important missions.

A negro army.

The new king, Merienra, was the son of Pepi and his queen Rameri-Ankhnas. His reign was short, but distinguished by a royal progress up the Nile as far as the cataracts. An armed vessel of war and twelve smaller vessels formed the royal fleet, and a point was reached higher up the river than had ever before been visited by a Memphian king. Inscriptions still visible at Assouan (the ancient Syene), on the right bank of the Nile, near the Nubian border, record the voyage and safe return of the king. He brought back masses of alabaster from the quarries, excavated basins or docks for the reception of his ships, receiving from the negroes of the district, who would seem to have become his tributaries, timber necessary for the work: in each dock was set up an altar in honour of the protecting spirits of the king. On his return he loaded his boats with granite for the royal pyramid. The

A royal progress.

periodical inundation of the Nile favoured the return journey of his heavily laden fleet.

The brother of Merienra, another Neferkara, succeeded to the throne, but the only memorable event of his reign of which any record has been preserved is another expedition to the mines in Arabia. After him we encounter the legendary figure of a queen, Nitocris, who would appear to be a creation of the Greek romancing historians. Singularly enough, they gave the same name to a queen of Babylon, famous, like the Egyptian, for beauty and audacity. She may or may not have reigned in Egypt, and the story of her inviting the murderers of her brother to a banquet in a chamber below the level of the Nile, and then flooding it and so drowning them, may have had some foundation in fact; but the legend is not sufficiently substantiated to warrant us in accepting it as authentic history. Certainly there are no monumental records of her reign. A few other kings are named, but nothing remarkable is connected with their names. About two thousand years before the Christian era the sixth dynasty came to an end, and with it the period generally described by investigators of Egyptian history as the Old Monarchy, to be succeeded by the Middle Empire, in sketching which we shall find ourselves in contact with more familiar histories.

A legendary queen.

As yet Egypt was the only spot on the vast surface of the earth in which there was any approach to civilization or regular government, any systematic knowledge of science or art, anything like a national literature, or any evidence of a religious faith, regulating the morals and social life of the community. In the ensuing chapters of this brief history, we shall encounter the facts of the rise of the Babylonian power, and the appearance of the children of Abraham in Egypt; and from other and long accepted records obtain new light by which to trace the progress of the country of Old Nile.

Early civilization.

II.

VALUE—WAGES—PROFITS—RENTS.

VALUE.

THE exchange of commodities following upon "division of labour," implying, as we have seen, that things exchanged shall be fairly worth each other to both parties in the transaction, the question of Value becomes one of the highest importance in economic science. A definition of value is not enough. The subject in its full compass may be said to present itself in this threefold inquiry:—What is value? What the constituents of value? What the means provided by the natural laws of economy for equity of value in exchange?

Let us here observe in a word that equalness of value in things exchanged does not involve the consequence of exchange being null and void—both parties being no better off after than they were before the transaction. A bushel of wheat and a stone of beef, for example, may be perfectly equal in value, and yet the wheat be more valuable than the beef to the holder of the latter, and *vice versâ*. A gain on both sides is the result of every true act of exchange.

The term "Value," in its general acceptance by economists, is the proportion or ratio in which commodities exchange against each other. The value of a commodity begins in what the commodity costs in its production; but it does not stop at that point, and is only determined by the commodities for which it exchanges, or which its "price" purchases in the markets. The connection of value with exchange is fundamental, and is all the more necessary to be kept in view, since there is also a "value in use," which is so different that it may be enjoyed without having any value in exchange, and yet is an element so essential to value in exchange that it is never separate from this value, and has important effects upon it throughout. No commodity commands value in exchange without "value in use," or utility in some form or other. The air we breathe, for example, though the most necessary and useful of all things, is not merchantable until something has to be done by man himself to provide it—as in the diving-bell, or as when by outlay of labour and materials a sanitary improvement is made in a dwelling-house; when in both cases, and all similar cases, a supply of air, or of purer air, acquires at once a value in exchange. Or, as at the other end of the scale of value, bread for example, the staff of life to every one, however plentifully or cheaply produced, as soon as the supplies from all sources happen to be less than enough, rises more rapidly in value in virtue of its primary utility than articles of secondary utility in the same case, such as dress or furniture, and all commodities, in short, of which one can take more conveniently less or more, as the circumstances may be. A high price of bread, indeed, has usually been found to cause the value of such commodities to fall.

What is value?

Enough has thus probably been said, not only to distinguish value-in-use and value-in-exchange, but also in a brief way to answer the question "What is value?" in the accepted and scientific sense here under consideration. It is the value in exchange of commodities one with another; and for practical purposes seems sufficiently defined in the term "exchange-value,"—in other words, the commodity which another commodity, or its selling price in money, commands in the markets.

The basis of exchange-value of every commodity is the cost of its production. But the cost of producing commodities is, of course, as various as the commodities themselves, and it is only by a comprehensive survey that one can arrive at uniform elements of cost of production. Mr. Mill, in an analysis which has never been, or never can, we suppose, be disputed—an analysis extending over the general

The constituents of value.

range of human industries, whereby it is found that every branch of production is indebted for materials, tools, or implements to some preceding branches, and receives into its hand for its own special purpose the accumulated labour and expended capital of many other branches—arrived at the conclusion that "the universal elements of cost of production are the wages of labour and the profits of capital." Among "occasional elements" Mr. Mill noted "taxes," and "extra cost occasioned by scarcity-value of some requisites."*

Mr. Mill gives to "profits of capital" an extended meaning, including apparently "fixed" as well as circulating capital; but for capital in land, buildings, and even in some cases industrial fixtures, such as engines or other apparatus of production, the profit of capital takes the form of "rent." Thus wages of labour, profit of capital required in purchase of materials, or in stock or money, and rent of land or buildings, etc., are usually taken as the contents of cost of production. Professor Cairnes, in a careful discussion of value,† takes exception to the term "cost" where the thing signified is clearly the "reward of production," the "cost" being the sacrifices made by the various persons co-operating in the production. Hence, his ultimate elements of cost of production are Physical and Mental Exertion = Labour; Abstinence = Capital; and Risk. But this, while a proper enough distinction to make, does not alter materially, even in the hands of Mr. Cairnes, the usual analysis into Wages, Profit of Capital, and Rent; and to make this analysis complete it would seem necessary only to add the rise or fall of value from the action and reaction of supply and demand; because if a commodity increases or diminishes in value from the fact of its being too limited or too abundant in supply, there seems no reason why this should not be deemed a constituent of value as well as a rise or fall of wages, profits, and rents. What the producer of a commodity has outlaid in wages, profit of capital employed, and rent, is to him the cost of its production, and thus becomes the "cost" or "normal" value of the commodity, to be further tested in the market, not only by the many producers of the same commodity, but by the demand for the commodity applying equally to all the producers. What in the experience of the producers is found to be the "cost" or "normal" value of a commodity is the value to which it always tends in the fluctuations of the market. The market-value can never much rise or fall below this point, or vary otherwise for any considerable period, without an immediate action in correction of the difference. When a commodity falls in market-value below the cost-value, one of two results ensues. The cost of production will either be reduced by a stricter economy—by a lowering of wage, profit, or rent, or by some improved mechanism or skill in production—to the level of the prevailing market-value; or the production of that commodity will decline until the supply is no more than the actual demand is sufficient to cover in its cost of production. When a commodity, on the other hand, rises in market-value above the cost or normal-value, the production of it will increase, more hands will be employed, more labour and more capital will be drawn to it by higher wage and higher profit, till an equilibrium between "cost" and "market" value be again established. Under the free and natural movement of capital and labour, therefore, the market-value of commodities always more or less quickly returns to their actual cost-value, while due vigilance is impressed at the same time both on employers and workmen as to what they are doing, in whatever branch they may be engaged.

This concluding part of the question of value has already, in a degree, been overlapped in the foregoing remarks. It will be observed that in the "division of labour" people became free to choose their occupations severally; that in the exchange of commodities necessarily following, "free and open markets," wherein commodities could be compared, judged and fairly poised against each other in exchange, became an equally necessary consequence of the economic evolution; and so, as the complication of industry and trade increases, the same principle of individual choice and freedom of action is found to be the only course on which this problem can be solved. No authority in the world, or to be conceived, can pretend to prescribe how much commodity is to be produced this year or the next, or by whom to be produced, or what this or that person should do with his labour or his capital; and political economy is thus thrown upon a quiet but not ineffectual observation of what the natural interest of all the parties is, as shown in their own action and its results. The security for equity of exchange-value rests in the principle that every occupation shall be freely opened to labour and capital, and that there shall be such an effective competition, not of labour against capital or of capital against labour, but of labour with labour and of capital with capital, as to succeed in equalising the rewards of industry throughout the whole sphere of production.

Means of equity in exchange-value.

WAGES—PROFITS—RENTS.

In the two preceding sections the reader will have seen—in imagination, indeed, much more than in our brief suggestion—a vast industrial system, organising itself under a natural process of development, and branching out in innumerable divisions of labour to reunite in the markets, to transact the exchange of their several products, and to reap the rewards a free pursuit of which has been the motive-power of the whole movement. Save in the glimpse given, however, of the principles of Value, whereby in virtue of freedom of labour and capital a more or less exact equivalency arises and is maintained in the exchange of one commodity for another, what has so far been said bears chiefly on the production of commo-

* "Principles of Political Economy," Book III., chap. iv., ss. 1, 4, 5; chap. vi., s. 1.

† "Some Leading Principles," Part I., chap. iii.

dities. Hence it is proposed, in what follows, to glance at the distributive action of the economic laws. These include laws of heirship, or division of the land, money, or goods a man or woman, or both as married persons, have acquired, and which is governed by will of the owners, or in default of will by positive laws of the commonwealth. Though not entered upon here, yet this must be noted as an essential part of the study.

The distribution of wealth, in its immediate sense, as comprehended under the three heads of Wages, Profits, Rents; and these sources of reward have their co-relative terms on the productive side of the account, in Labour, Capital, and Land. These are the agents of production, and though each is a vast subject in itself, and is much diversified in form,—so much so, indeed, that in one form of labour it would be difficult to discern any exact semblance of labour in another form, and that capital has not only its "fixed" and "circulating" forms, but shades off into degrees of mere credit; while as regards land, it would seem necessary to include the productive sea, standing in its vast yet free broadway of waters like a divine monition of the community of well-being in human affairs, and for transport purposes a'one become an important agent of production;—yet, for all practical results, labour, capital, and land may be taken as the general sources of production of wealth, with wages, profits, and rents, as their outcoming rewards.

PRINCE OF CONDÉ.

XXXI.

The Thirty Years' War (*continued*).

The command of the army was now transferred to the emperor's son Ferdinand, the king of Hungary, who wisely followed the counsel of Gallas, an experienced, though not generally a fortunate leader, by whose advice and assistance he took Ratisbon and Donauwörth, and then proceeded to besiege Nordlingen, in Bavaria. Here Bernhard of Weimar and the Swedish general Horn were miserably defeated, Horn being taken prisoner and nearly the whole of the Swedish and Saxon artillery lost. This battle once more gave the preponderance to the house of Hapsburg. The Swedes lost many towns; and Bernhard of Weimar hastened to Lorraine to seek assistance from France. The elector of Saxony now sacrificed the Swedes to secure his own safety, and concluded a separate treaty at Prague with the emperor, who was glad, at the cost of confirming the concessions of the treaties of Passau and Augsburg, and abrogating the obnoxious edict of restitution, to secure an accommodation to which Brundenburg, Weimar, and other important principalitics soon gave in their adhesion. Baden, Hesse Cassel, and Würtemberg were the only German powers which remained faithful to the Swedes.

Battle of Nordlingen, Sept. 6, 1634.

It seemed that Ferdinand had now once more the power to put an end to the terrible war; but his idea of terminating the strife without reckoning with the foreigners failed utterly. The edict of restitution had brought the Swedes into the empire; the treaty of Prague called in the French. Richelieu, the French minister, bold, astute, and unscrupulous, was, above all things, anxious to decrease the power of the Hapsburg house, and to prevent its extension towards the Rhine; consequently, he gave to Oxenstierna and to Bernhard of Weimar such effectual assistance that the war was renewed as vigorously as ever, and now assumed a political instead of a religious character.

Richelieu and his policy.

At the battle of Wittstock, Baner, the most efficient of the Swedish leaders, gained a great victory over the combined army of Saxons and imperialists, under Hertzfeld. All traces of the strict discipline of Gustavus Adolphus had by this time vanished out of the Swedish army; and the conquerors inhumanly punished the unhappy inhabitants of the districts between the Oder and the Elbe for the faithless policy of their ruler. Whole districts were converted from blooming gardens into unpeopled wildernesses, towns were depopulated, ravaged, and burnt. The long war had utterly demoralized the soldiery, who inflicted horrible cruelties upon the citizens and peasants whom their rapacity had ruined. The religious character of the contest had by this time entirely vanished; and in the various armies, Papists, Lutherans, and Calvinists, Germans

Baner's victory at Wittstock, Oct. 4, 1636.

and foreigners fought side by side, united only by a common lust for cruelty and plunder. At this juncture the emperor Ferdinand I. died. His days had been evil; strife and bloodshed had been the argument of the nineteen years of his ill-omened reign. Bigoted, selfish, and ungrateful, he established no claim to the respect or gratitude of his own time or of posterity.

Ferdinand III., the son and successor of Ferdinand II., continued the war. Bernhard of Weimar now gained a brilliant victory at Rheinfelden over the imperial general, Johan van Werth, whom he took prisoner. He captured Freiburg, and was said to cherish the idea of founding an independent principality for himself on both sides of the Rhine, when he suddenly died, in the zenith of his fame and fortunes. The French government took swift advantage of Bernhard's death, by seizing Alsace, and holding that fertile province by means of Duke Bernhard's army, whom Richelieu took into French service and pay. In southern Germany, the French, under Marshal Guebriant, and afterwards under the Duke d'Enghies (Condé), and the celebrated Turenne, continued the war. Baner, whose career of success brought new and increased sufferings on the unhappy Bohemians, for a time upheld the cause of the Swedes; and though Ferdinand III., appalled at the horrible devastation of the empire, conscientiously desired the conclusion of the strife, the war continued to rage year after year. France had now likewise made an alliance with Holland against Spain, and Condé gained the important battle of Rocroi.

Ferdinand III., 1637–1657.

Condé and Turenne. Battle of Rocroi, May 1643.

And now the concluding period of the lengthened struggle brought forward two other eminent Swedish leaders, Fortensohn and Wrangel. The former of these, the most efficient commander of the school of Gustavus Adolphus, carried the war into the hereditary states of the emperor, and made Ferdinand tremble in his palace in Vienna. At Leipsic he won a victory over Piccolomini, several times compelled Silesia and Moravia to submission, and forced Christian IV. of Denmark, who had commenced hostilities, to sign the treaty of Brömsebro, which secured important privileges to Sweden. Again he hastened to Moravia, and thence to Bohemia, his course marked by victories of which the principal was that over Gallas at Guterbogk. He menaced Vienna itself, but was induced at last, by ill-health and by want of support, to lay down his command in anger. His successor, Wrangel, effected a junction of the Swedish with the French forces after the victory of the latter at Allersheim, near Nördlingen. Maximilian of Bavaria was obliged to conclude an armistice with his enemies, for even Bavaria could not stand against the junction of Wrangel with Turenne. The troops now fought more for plunder than for victory. Every part of the German empire in turn had been devastated by the war, but nowhere had it raged so furiously as in Bohemia. In that unhappy country nearly three-fourths of the inhabitants had actually been swept away, 800,000 being the survivors of a population of three millions. Turenne and Wrangel having withdrawn their troops, Maximilian once more joined Austria, and once more the unhappy country had to pay for the treachery of its ruler; for the two generals advanced once more, and the exhausted country was laid waste with ruthless cruelty; and Bohemia, Silesia, and Austria in turn felt the heavy hand of the devastator, and again the smoke of the torment of the citizen and peasant went up to heaven. Fortune favoured the French and Swedes. At Susmarshausen, near Augsburg, they gained a victory on the 7th of May, 1648; and the Swedish general, Konigsmark, laid siege to Prague, and succeeded in taking a part of the city. But the unnatural strife was destined to end at Prague, where it had begun. For more than five years negociations had been carried on between the emperor for the Catholics and the Swedes for the Evangelicals at Osnabruck, and between Germany and France at Munster. The selfishness and the mutual jealousies of the powers had retarded the proceedings; but at length, on the 24th of October, 1648, treaties were signed at Osnabruck and Munster; and the news flew through the distracted empire that the miserable land, after thirty years of burning, plundering, and massacre, was to have rest at last.

Last period of the war.

Peace signed at Munster, Oct. 24, 1648.

The chief conditions of the treaty of Westphalia were the following:—Sweden was indemnified for her sacrifices and exertions by the acquisition of Pomerania, the archbishopric of Bremen, the town of Weimar, and the bishopric of Verden, with a money payment of five million dollars. The Netherlands and Switzerland, till now considered as parts of the German empire, had their position as independent states formally acknowledged. France came well off in the struggle for the spoils of war. She obtained the bishoprics of Toul, Metz, and Verdun, and Upper and Lower Alsace, which were formally ceded to her, besides Breisach, Pignerol, and other territories. Brandenburg, now rising into importance under the "great elector" Frederick William, received Halberstadt, Minden and Camin, and the duchy of Magdeburg. Charles Louis, the son of the unfortunate "Winter King," Frederick V., was restored to part of his dominions, and received into the empire as an eighth elector. In the empire itself, the authority of the emperor was so decreased that, indeed, it became a mere shadow of what it once had been. The princes of the empire now ruled as independent sovereigns. The armies of mercenaries raised during the war were retained as a weapon in the hands of the princes for keeping down all popular demonstrations for liberty. Germany crystallized into a number of separate despotisms, in each of which the government, aided by an enormous number of officials, taxed the

Treaty of Westphalia.

Effect of the war on Germany.

people without let or hindrance, and produced everywhere the mournful spectacle of luxurious courts and impoverished communities. The German empire continued nominally to exist for another century and a half; but in reality it was only a federation of states, with separate interests, governments, and laws; and with no internal bond of union among themselves. The political power of Germany, like her prosperity and material well-being, was utterly overthrown by the Thirty Years' War.

With regard to religious matters, the provisions of the treaties of Passau and Augsburg were declared to be in force, and the privileges granted to Lutherans were extended to the Calvinists. With regard to ecclesiastical possessions, the year 1624 was taken as the normal or departure year,—all rights that had existed in that year to be restored and recognized. Political considerations had by this time thrust religious questions into the background, The freedom of religion guaranteed by the treaty of Westphalia was more apparent than real; at a later period the will of the separate rulers decided the position of the Church and the amount of toleration in each part of Germany.

Religious freedom guaranteed.

So far as the material prosperity of Germany was concerned, the Thirty Years' War brought complete and irremediable ruin. Taking one part of the empire with another, more than half the population had been swept away by famine, sword, and pestilence. In many districts cultivation had entirely ceased, and desert wildernesses overgrown with heath lay extended where once fields and meadows had smiled with rich harvests. Many villages had been entirely depopulated, and smouldering ruins marked where farmsteads and labourers' cottages had once been. The trading and manufacturing towns had suffered cruelly. Their glory had departed, in many cases to return no more. Augsburg, that had once counted 90,000 inhabitants, could muster barely 6,000 when the Thirty Years' War was over. In Saxony 900,000 people had perished within two years. In the interval between the peace of Augsburg in 1555 and the end of the century, Germany had engrossed much of the commerce of which Portugal had been deprived. Great commercial roads traversed Germany from Dantzic to Genoa, and from Nuremberg to Lyons. But all this was now gone: the workshops were deserted, and the trade had passed into the hands of the English, the French, and the Dutch.

Harte, in his life of Gustavus Adolphus, gives some terrible details of the misery that had fallen upon Germany. "The famine," he tells us, "during the greater part of these wars, kept pace with the pestilence. Wheat was sold, more times than once, for three pounds eighteen shillings a bushel. Guards were posted to protect the newly-buried from being devoured. There were instances of children being led away, massacred, and eaten up. Two women fought for a slice of a dead horse, and one killed the other. A straggling beggar decoyed away a poor woman's child, and began to strangle it in order to eat it; but the vigilant mother surprised her in the act, and killed her. The face of the earth was ruined for want of agriculture; and every eatable animal was so greedily searched for that the beasts of prey missed their daily food. When Lord Arundel passed through the empire, on his return from his embassy to Vienna, a fox crept out of a brake and seized one of his attendants by the leg. The man took it up, for it was so weak it could not escape; its eyes were haggard and sunk in its head, and it weighed next to nothing." And an old chronicler exclaims: "In what a miserable condition are our cities! Where there used to be thousands of streets there are not hundreds now. The citizens have been driven into the water by thousands, hunted to death in the forests, cut to pieces, their hearts torn out, their ears, noses, and tongues cut off, the soles of their feet gashed, strips of flesh cut out of their backs; men, women, and children so barbarously and shamefully treated that it is not to be imagined. How miserable is the look of the little towns and open villages! There they lie, burnt, destroyed—not a roof, beam, door, or window remaining. As for the churches, they have been burnt, the bells carried away, the holiest places turned into stables, market-houses, and worse." It is not too much to say that Germany was thrown back a century and a half in the race of civilization by the crimes and calamities of this terrible contest.

Lamentable effects of the war.

V.

Inductive Electricity (*continued*).—Electrical Machines.

In addition to our knowledge of the manner in which electricity is spread over the surfaces of electrified bodies, it is also easily shown that electricity has a tendency to seek those surfaces rather than to occupy the interior. A very simple and interesting way of showing this is by means of Faraday's net, which is shown in fig. 16.

Faraday's net.

As will be seen, it consists simply of an ordinary butterfly net mounted upon an insulating stand, and provided with a string, by which it can be turned inside out. If to such a net a charge of electricity be given, it will be found, upon testing it with a proof plane, that the interior gives no indication of electricity, while the exterior is found to be electrified. Now turn the net inside out, and it will be found that the surface which is now inside, and was a moment ago outside, gives no indication of electricity, while the surface which is now exterior, and which was just now interior, is powerfully electrified.

Another method of showing the same facts—

also due to Faraday—is shown in a diagram on p. 101. Fig. 12 represents a roller mounted upon glass insulating supports, and having upon it a long strip of tin-foil. To the tin-foil are attached by cotton threads two small pith balls. Upon giving to the tin-foil a charge of electricity, the pith balls will of course diverge; but it will be found that if the tin-foil be unrolled they will gradually collapse, owing to the diffusion of the electricity, whereas if the foil be rolled up they will again diverge. Here the electricity refuses to stay upon the rolled up portion of the foil, and seeks the flat portion, where it becomes concentrated, and from whence it passes to the pith balls. Another easier method of performing the same experiment is to simply roll a long strip of tin-foil upon a glass rod, and connect the free end of the foil with the electroscope by a piece of copper wire. By holding the glass rod in the hand, and giving, by means of the proof plane, small charges of electricity to the foil, the movements of the leaves of the electroscope, as the foil is rolled up and unrolled, will indicate the manner in which the electricity is spread over its surface.

Another method of illustrating distribution.

The distribution of electricity upon the surfaces only of bodies is also well illustrated by the following experiment. Fig. 17 is a sphere of brass mounted upon a varnished glass pedestal. To this sphere a charge of electricity is given, and then two hollow hemispheres, held by insulating handles, are placed over it; upon being removed, it is found that while no electricity is present upon the inside surfaces of the hemispheres, their exterior surfaces at once give indication of a change.

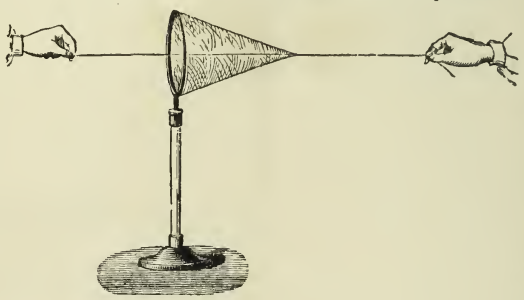


FIG. 16.—FARADAY'S NET.

All these experiments tend to show that electricity confines itself to the surfaces of bodies and avoids the interior, and a number of further experiments illustrating the same fact will doubtless suggest themselves to the student. Any insulated hollow body, such as a hat or a glass covered with tin-foil, may be employed, with invariably the same result.

Having now made ourselves acquainted with some of the more important fundamental facts of electricity, we shall be enabled to understand the structure and principle of those larger pieces of apparatus for generating electricity which we term *par excellence* electrical machines.

Electrical machines.

The earliest electrical machine, devised in the year 1670 by Otto von Guericke, burgomaster of Magdeburg, consisted merely of a ball of sulphur which was excited by friction with the dry hand. Since this, however, numerous arrangements have been devised for obtaining electricity upon a larger scale than can be done by any of the methods we have yet described; and we will now endeavour to give such a description of the most common forms, that any one with a little ingenuity may at a small cost make them for himself.

Earliest form of electrical machine.

One of the oldest and most easily constructed of electrical machines is the so-called cylinder machine, the appearance of which is familiar to most students.

The cylinder machine.

It consists of a glass cylinder which is made to turn upon an axis supported on a wooden frame, and turned by a handle. What is known as the prime conductor of the machine consists of a brass cylinder with rounded ends, mounted upon varnished glass legs, and having upon its inner side a number of small spikes which extend from the prime conductor to the glass cylinder but do not quite touch the latter.

On the opposite side of the cylinder is a pad or cushion, made of several layers of flannel and covered with a piece of black silk, which is so arranged as to extend in the form of a flap over nearly the whole of the upper surface of the cylinder. The cushion is supported on a varnished glass leg similar to those which support the prime conductor, and like the latter, it should have its ends well rounded. The silk flap and rubber being covered with mercury amalgam (which we will presently give instructions for making), the handle is turned, and the cylinder revolving, electricity is generated, which may be drawn from the ends of the prime conductor in the form of sparks.

Before giving the theoretical explanation of the action of this machine, we will give a few hints to those who may desire to make one. The glass cylinder may be bought at a glass blower's, where they usually keep some on hand. In selecting the cylinder care should be taken to see that it is, as far as possible, "true." The cylinders are usually sold by the pound, and one about ten or twelve inches long (which is a convenient size) should cost somewhere about three shillings. The stand of the machine should be of dry, well-seasoned wood (mahogany is the best), and after being made as smooth as possible may be stained or varnished to improve its appearance. For the axis of the cylinder an ordinary round ruler passed through from end to end answers very well, though it will be better if the ruler can be dispensed with in the interior of the cylinder, in which case turned caps to fit on the ends will be required. For cementing on these caps, or for fastening the axle in the

How to make a cylinder machine.

cylinder, a mixture of resin and shell-lac in about equal parts, used hot, will be found to answer best. The uprights which support the axle may both be of well-seasoned wood.

The prime conductor may be made from a piece of brass tubing about an inch and a half in diameter, and for the rounded ends the knobs of two small door-handles may be used. Upon the side of the conductor which is to face the cylinder about a dozen small brass tacks may be fastened. The best way to do this is to get a narrow strip of thin brass and to put the tacks through it, soldering them so as to keep them firm; then carefully solder the strip of brass to your prime conductor, the glass supports of which may be made to fit into sockets upon its under surface.

The prime conductor.

The rubber may be made of several layers of perfectly dry flannel, put on as evenly as possible. The flap of silk (which should have its raw edges neatly hemmed), must be tacked on to the under-surface of the rubber and then brought up in front of it and allowed to lie looscly upon the upper surface of the cylinder. Care should be taken to round off as much as possible every corner and edge of the machine, so as to prevent the loss of any electricity by discharge into the atmosphere. Upon the back of the wooden or brass rod to which the rubber is fastened should be placed a small hook, to which a chain may be attached in order to connect the rubber with the earth. If wood be used for this rod, it will be found advantageous to fasten a narrow strip of tin-foil upon its under surface, and to connect this by a small piece of wire with the hook at the back. Wood may also be used for the support of the rubber, but in this case only one kind of electricity can be obtained from the machine. If this plan be adopted, a very good method is to hinge the support of the rubber on to the bottom of the stand, and then get a round piece of solid vulcanite, and fastening one end of it to the rubber-support, pass the other end through a small brass eye on the stand. By this means you can easily regulate the force with which the rubber presses against the cylinder.

The rubber.

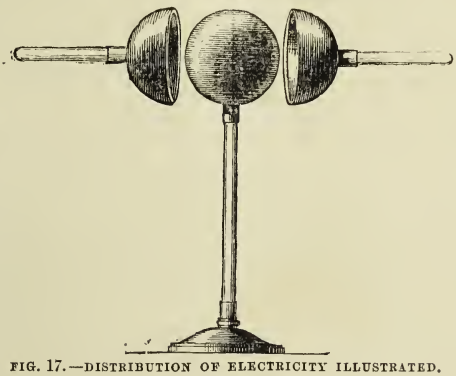


FIG. 17.—DISTRIBUTION OF ELECTRICITY ILLUSTRATED.

The mercury amalgam for use upon the rubber is made as follows: melt in an iron ladle one ounce of tin; to this add gradually one ounce of zinc scraps; thoroughly mix these with an iron stirrer, and then allow the mixture to cool until nearly solid; remelt, and add two ounces of hot mercury. Stir, throw into a warm iron mortar and stir up with an iron pestle till cold. Keep in a stoppered bottle. When used mix with the amalgam a *very littl* lard which has been well washed and dried. Spread a little of this mixture upon the rubber of your machine, and also upon the silk with which you rub your glass rod; it will be found to greatly add to their efficiency.

How to make amalgam.

With this description and a little patience we feel sure that any one may make a cylinder machine; but in order to make the matter perfectly clear the student should endeavour —not at all a difficult thing in these days—to see one in actual operation.

It remains now only for us to explain the principle upon which the machine works. The rubber being connected with the earth by means of a chain passing from the hook on the back to a gas pipe, fender, or other large metal object which is a good conductor, the handle is turned, and by the friction of the rubber upon the glass positive electricity is generated upon the latter and negative upon the silk. The glass, being a non-conductor, carries the positive electricity round to the prime conductor, the spikes of which receive it, and it enters the prime conductor, from which, being insulated, it is unable to escape. The prime conductor thus becomes positive by accepting part of the positive electricity of the glass, and the latter, passing onwards, again reaches the rubber. While this has been going on the negative electricity has been conducted away from the silk and rubber by the chain to the earth, and from the latter source a fresh supply of positive has arrived, so that the rubber is again neutral. The still positively charged cylinder reaching the cushion again decomposes its electricity, and robs it of its positive, which is again taken to the prime conductor. If instead of the rubber, the prime conductor be connected with the earth, negative electricity will, *if the rubber be insulated*, accumulate on the latter.

Principle of the cylinder machine.

ARITHMETIC.

XXXI.

DECIMALS (*continued*).

To reduce a Vulgar Fraction to a Decimal.

WE have seen that a vulgar fraction may be considered as representing the quotient which would arise from dividing its numerator by its denominator. Hence we can express any vulgar fraction as a decimal, for we have only to

write down as dividend the numerator with a decimal point and as many annexed ciphers as we wish, and write as divisor the denominator, and then proceed as in division of decimals.

Example.—Express $\frac{8}{25}$ as a decimal.

25)8·0(·32
75
—
50
50
—
Ans. ·32

When the quotient arising from any division is exact, as in the present case, the decimal is called a "terminating" decimal. But frequently we find that no matter how far we carry on the division, we can never arrive at an exact quotient, so that the fraction cannot be expressed exactly as a decimal, though we may approximate to it.

The following considerations will enable us to see what fractions can be exactly expressed as decimals, and will also prove that certain fractions cannot be exactly expressed.

Every decimal is a fraction which has some power of 10 for its denominator. Therefore, to convert a fraction into a decimal means to convert it into an equivalent fraction having some power of 10 for its denominator.

Now, we may multiply the numerator and denominator of a fraction by any multiplier we please. If, then, we can find a multiplier which will make the denominator a power of 10, the fraction can be converted into an equivalent fraction having the power of 10 for its denominator—*i.e.* it can be converted into a "terminating" decimal. But if there is no such multiplier, there cannot be an equivalent terminating decimal.

Now, $10 = 2 \times 5$, $\therefore$ any power of 10 = same power of 2 $\times$ same power of 5. Therefore any number, the prime factors of which are 2's and 5's only, can be multiplied by a number which will make it a power of 10. For instance, $250 = 2 \times 5 \times 5 \times 5$; and if we multiply it by 4 we have

$$\begin{aligned} 250 \times 4 &= 2 \times 2 \times 2 \times 5 \times 5 \times 5 \\ &= (2 \times 5) \times (2 \times 5) \times (2 \times 5) \\ &= 10 \times 10 \times 10 \\ &= 10^3; \end{aligned}$$

i.e. we have as the result the third power of 10.

In the same way 8 can be multiplied so as to give a power of 10; for $8 = 2 \times 2 \times 2$,

$$\begin{aligned} \therefore 8 \times 5 \times 5 \times 5 &= (2 \times 5) \times (2 \times 5) \times (2 \times 5) \\ &= 10 \times 10 \times 10 \\ &= 10^3 \end{aligned}$$

But 24, $= 2 \times 2 \times 2 \times 3$, cannot be multiplied by any number which will make it a power of 10, because of the factor 3.

If, then, the denominator of the given fraction be a number whose prime factors are either 2's or 5's, or both 2's and 5's, and no other factors, the fraction can be converted into a terminating decimal; but if it has any other prime factors beside 2's and 5's, it cannot be expressed as a terminating decimal.

Example.—The fraction $\frac{3}{40}$

$$= \frac{3}{2 \times 2 \times 2 \times 5} = \frac{3 \times 5 \times 5}{2 \times 2 \times 2 \times 5 \times 5 \times 5}$$

$$= \frac{75}{10 \times 10 \times 10} = \frac{75}{1000} = \cdot 75.$$

But the fraction $\frac{9}{28} = \frac{9}{7 \times 2 \times 2}$,

and nothing that we can multiply this denominator by will make it a power of 10, because of the factor 7. So that the fraction $\frac{9}{28}$ cannot be expressed as a terminating decimal.

But though some fractions cannot be expressed *exactly* as decimals, since they cannot be converted into equivalent fractions having a power of 10 for denominator, yet *any* fraction can be converted into a decimal whose value *approximates as closely as we please* to the exact value of the fraction. We have only to divide the numerator by the denominator according to the rules already explained; and if we carry on the division sufficiently far, we must get either a terminating decimal, or one which differs from the true value by a quantity as small as we please.

Take the fraction $\frac{9}{28}$.

28)9·0(·3214
84
—
60
56
—
40
28
—
120
112
—
8

Here, by the rule, we find as quotient ·3214....., and other figures which we may work out if we please; and we have already seen that each new figure in the quotient brings us nearer the true result.

If we take only one figure we have ·3 as an approximation to the true result. Now, the true result is greater than this ·3 and less than ·4. So that the error arising from taking ·3 as the true value is less than ·1.

Again, the true value is more than ·32 and less than ·33, so that the error arising from taking ·32 as the true value is less than ·01. Similarly, the error arising from taking ·321 as the true value is less than ·001, and so on; the error arising from stopping at any number of places diminishing at every step. We have already shown the same thing in a different way.

Exercises.

Express as decimals the following vulgar fractions:

1. (*a*) $\frac{3}{5}$; (*b*) $\frac{7}{50}$; (*c*) $\frac{3}{20}$; (*d*) $\frac{4}{25}$; (*e*) $\frac{9}{50}$; (*f*) $\frac{6}{25}$; (*g*) $\frac{5}{4}$; (*h*) $3\frac{3}{4}$; (*i*) $\frac{11}{20}$.

2. (*a*) $\frac{161}{250}$; (*b*) $\frac{53}{31250}$; (*c*) $\frac{64001}{64000}$; (*d*) $17\frac{17}{123}$ (*e*) $\frac{13}{64}$; (*f*) $\frac{7}{15720}$; (*g*) $\frac{\frac{21}{19} \text{ of } 1\frac{1}{75}}{3\frac{1}{2}}$; (*h*) $\frac{9}{31250} \div \frac{2}{15}$; (*i*) $\frac{31}{16}$ of $\frac{1}{2}$ of $\frac{22}{125}$.

Answers.

1. (*a*) ·6; (*b*) ·14; (*c*) ·15; (*d*) ·16; (*e*) ·18; (*f*) ·24; (*g*) 1·25; (*h*) 3·75; (*i*) ·55.

2. (*a*) ·644; (*b*) ·001696; (*c*) 1·00015625; (*d*) 17·1328125; (*e*) ·203125; (*f*) ·0013671875; (*g*) ·32; (*h*) ·00216; (*i*) ·1705.

Circulating, Recurring, or Repeating Decimals.

A decimal in which any series of figures is repeated over and over again in the same order an indefinite number of times is called a "circulating," or "recurring," or "repeating" decimal, these names being synonymous.

Thus, ·0898989...., where the figures 89 are repeated in the same order an indefinite number of times, is a circulating decimal. So is 3·457327327327....

The series of figures which are repeated is

called the "*Period*"; the figures which do not recur constitute the *Finite part*. Thus, in the above decimals, 89 and 732 are the periods, while 0 and 45 are the finite parts.

It is usual to indicate a recurring decimal by writing the figures to the end of the first period, and putting a dot over the first and last figures of this period, to show what figures are repeated.

Thus, the foregoing decimals are written shortly, ·089 and 3·45732.

A *Mixed* circulating decimal is one which has both finite part and period.

A *Pure* circulating decimal is one which has no finite part, the period commencing immediately after the decimal point.

We have seen that some fractions give rise to terminating decimals, and others to non-terminating. We shall now show that every one of these non-terminating decimals is a recurring decimal.

For if in the process of division we come to a remainder the same as *any* previous remainder, it is evident the whole series of intermediate remainders and quotients will be repeated in the same order, over and over again *ad infinitum*.

Now, if we go on long enough, we *must* come to some remainder which we have already had; for every remainder must be less (by unity at least) than the divisor. Therefore the whole number of *different* remainders cannot be a number greater than the divisor. So that in that number of steps, at most, some remainder which has already occurred must recur.

An example will make all this abstract reasoning clear enough.

Suppose we have any fraction, say $\frac{9}{28}$, which we converted into a decimal (see p. 134).

Now, looking back to the work, we see that all the remainders are, *and must be*, less than the divisor 28. Therefore the only possible remainders are 1, 2, 3, 4, ... up to 27. So that in 27 steps, if not sooner, some one of these remainders must occur a second time, and therefore from that point the figures in the quotient will recur, ∴ the remainders are the dividends from which the figures in the quotient are got.

Example 1.—$\frac{5}{9}\frac{2}{2}\frac{1}{5}$.

999)5210(·521	Here, after three steps, we
4995	find the remainder 521, which
——	is the same as the dividend in
2150	the first step. Hence the quo-
1998	tient will be the same as the
——	quotient in the first step, and
1520	all intermediate quotients will
999	recur.
——	So that the quotient will be
521	a recurring decimal, viz., ·521.

Again: Example 2.—$\frac{3}{110}\frac{9}{0}$.

110)390(·354	Here the remainder after the
330	third division is the same as
——	that after the first, and there-
600 *	fore the next figure in the quo-
550	tient will be the same as the
——	second, and the two remainders,
500	60 and 50, will recur in order
440	as often as we like.
——	So that the quotient will be
600 *	·3545454...., *i.e.* ·354.

XXX.

The Sun (*continued*).

Reference has already been made to the bright *corona* seen to surround the sun during solar eclipses. By the aid of the spectroscope this has been shown to shine partly from reflected solar light and partly from inherent light of its own; so that it probably consists partly of solid particles and partly of incandescent gas. It is probable, therefore, that the corona consists of an immense number of minute meteoric masses, each surrounded by its own gaseous envelope, and rapidly revolving in its orbit round the sun. The greater masses of these meteors probably revolve in orbits which lie far within the orbit of Mercury; but many must move in orbits which extend far into the solar system. Observation has shown us that there are an immense number of streams of meteors moving in all directions round the sun, and in orbits of all shapes, but in general resembling in form the orbits of the periodical comets, and often closely associated with them. The earth is known to cross the path of several hundred of these meteor streams, and probably does cross the path of several thousand; so that the number in the solar system must be counted by hundreds of millions at least. Each of these streams must pass close to the sun, so that the entire region near the sun must be crowded with innumerable meteor streams. The solar corona, which is seen during solar eclipses, is probably due to these innumerable meteors swiftly flying round the sun, and radiating away in all directions into space,—the light of the *corona* being due partly to those of the meteors which have passed close enough to the sun to have been rendered white-hot, partly to their gaseous envelopes also rendered incandescent, and partly to the solar light reflected by them.

Meteoric origin of solar corona.

From careful observation of the spots on the sun it has been ascertained that the sun rotates on an axis inclined at an angle of 7° 17′ to the perpendicular to the ecliptic, once in 24 d. 23 h. 18·4 m. (Carrington), though according to Schwabe these quantities ought to be 25 d. 5 h. and 7° 17·7′, and according to Spörer 25 d. 5 h. 37 m. and 6° 58′. The longitude of the ascending node of the sun's equator is 73° 50′ according to Carrington, and 74° 48′ according to Spörer. Some uncertainty attaches to these determinations, because the solar spots seem usually to possess proper motion of their own, the spots nearer the equator moving quicker than those farther away.

Rotation of sun.

In form the sun seems perfectly spherical, the most careful micrometrical measures having failed to show any sign of our polar compression, though from its slow rotation on its axis

some such compression would not have been abnormal.

Seen from the earth, the mean diameter of the sun is 32′ 3·6″, but as the distance of the earth varies, so does the apparent diameter of the sun—it being at its smallest, or only equal to 31′ 31·8″, on July 1st, when the earth is at its greatest distance; and at its largest, when it is equal to 32′ 36·4″, on December 31st, when the earth is at its least distance from the sun. It thus varies by 1′ 4·6″. The actual diameter of the sun is easily calculated when once the distance of the sun is known. If the solar parallax be taken at 8·80″, then the actual mean distance of the sun is 92,880,000 miles, or nearly ninety-three millions of miles; and from the apparent diameter of the sun, or 32′ 3·6″, the real diameter must be 866,000 miles.

Diameter of sun.

The methods for determining the real distance of the sun by determining the value of the solar parallax, or apparent displacement in the position of the sun as seen from different places on the earth, has already been described (*ante*, vol. I., page 541). It remains only to mention the values which have of late been determined; for unfortunately at present the exact value of this most important astronomical constant is not known with certainty. From the motion of the planets, M. Leverrier deduced a value which, after applying certain necessary small corrections, becomes equal to 8·84″. From a rediscussion of the celebrated transit of Venus of the last century, Mr. Stone found the value 8·91″. From the last transit of Venus, in 1874, Col. Tupman has found the value 8·84″; but unfortunately the observations made during this last transit have turned out to be so uncertain that this result is of very little weight. From an expedition to observe the parallax of Mars during the very favourable opposition in 1877, Mr Gill has obtained the value 8·78″. From the value of the parallactic inequality in the motion of the moon, Messrs. Neison and Campbell have obtained the value 8·78″ or 8·84″, but further research is required to determine which value is correct. From the photographs taken by the American observers during the transit of Venus, Mr. Todd obtains the value 8·88″. From the French photographs taken during the same transit, Mr. Stone has derived the value 8·88″. It will thus be seen that there is a very considerable uncertainty, the results ranging between 8·78″ and 8·91″; and as a change of 0·01″ in the solar parallax corresponds to a change of 104,000 miles in the distance of the sun, it will be seen that this uncertainty is not satisfactory. It is probable, however, that the true value is very close to 8·80″. If the solar parallax be taken as 8·80″, the distance of the sun from the earth will be 92,880,000 miles; and it is probable that this is within half a million miles of the truth.

Distance of sun.

FIG. 78.

The principal phenomena presented during solar eclipses have been already described, and at present they present few features of interest except in regard to what further information may be learnt about the solar corona; and it is doubtful whether this appendage to the sun should not be properly dealt with in the section of intramercurial planets, under which head of course comes the search for these bodies which can only be satisfactorily pursued during the course of a total solar eclipse.

Eclipses.

During every year there are at least two eclipses of the sun, and there may be as many as five in the one year; but the number visible from any one place on the earth is much smaller, and many years may elapse before a second total eclipse is visible at any given place. This is from the fact that a solar eclipse is never total over an entire hemisphere of the earth, but as a rule is only total over a narrow belt about one hundred miles in width, although it may be visible as a partial eclipse over a far wider area. It will not be for very many years that another total solar eclipse will be visible in England, nor even an annular eclipse.

Intra-Mercurial Planets.

When Leverrier, the famous French astronomer, had completed the first portion of his investigation of the motion of the planets, he found that he could not account for the observed motion of the perihelion of the planet Mercury unless he assumed the existence within its orbit of some unknown body or bodies having a mass amounting in the aggregate to nearly that of Mercury itself. Leverrier considered, therefore, that it was certain that there existed within the orbit of Mercury yet another planet or planets, or else a ring of small minor planets similar in size and character to the great belt of such bodies which exists between Jupiter and Mars.

Suspected existence of intra-Mercurial planets.

Which of these is the most probable? The question can now be answered with much greater certainty than it could be a quarter of a century ago, when it was first propounded.

If there be such a planet or planets, there are three ways in which it might be detected. Firstly, in the same way as the planet Mercury itself can be found—by watching the neighbourhood of the sun; when, if the planet were anything like half the size of Mercury, it could be detected, as it would shine with much greater intrinsic brightness, owing to its nearer proximity to the sun. Secondly, even if too small to be thus seen, during a solar eclipse the solar glare disappears, and stars of even the second magnitude can be seen quite close to the sun, whilst the planet Mercury shines forth most

Their probable nature.

conspicuously even to the naked eye. Any intramercurial planet large enough to shine like a first or even second magnitude star might be at once detected in this manner. Thirdly, when seen in transit across the solar disc, as the planet would be much closer to the sun than Mercury, it would be far oftener observed —probably at least once in every other year. Owing to the irradiation or the encroachment of the bright light of the sun upon the dark body of the planet, when seen in transit across the sun a planet is diminished in apparent diameter by over 2″ of arc, so that it would look smaller than its real dimensions, and so much less conspicuous than might otherwise be anticipated. If, however, the planet were 2000 miles in diameter when it crossed the solar disc, its real diameter would be about 5″ arc, so that it would appear like a small circular black spot some 3″ in diameter. It is not likely that such a spot could repeatedly cross the sun without being detected in transit.

If there were one such planet, it could not have a mass even half as great as that required by Leverrier's theory unless its diameter was equal to 2500 miles. Such a body would shine like a star of the first magnitude, and when it crossed the solar disc would appear like a spot over 4″ in diameter, whilst it would be visible at elongation as a beautiful exceedingly brilliant crescent some 7″ in greatest diameter. A planet of this kind could not have escaped detection, and a very careful search has been made for it without result.

Here, however, it is necessary to notice some remarkable observations which have been made, and which have led to the frequent suspicion of the existence of such an intramercurial planet. These observations consist of a number of instances, more or less well authenticated, where small dark circular spots have been seen to cross the whole or part of the solar disc, as if they were intramercurial planets in transit.

Supposed observations of intramercurial planets.

On November 19th, 1762, Lichtenberg, a young German astronomer, observed a large round spot upon the sun, and noticed its egress after having traversed a chord of some 70°. On March 29th, 1800, and February 7th and October 10th, 1802, Fritsch, another German astronomer, observed spots on the solar surface which moved in so exceptional a manner that it was supposed that they might be planets *in transitu*. On January 6th, 1818, a Mr. Capel Lofft and two others saw a small black spot move regularly across the sun, it disappearing shortly before sunrise. On July 12th, 1837, De Vico at Rome made a similar observation; and on October 2nd, 1839, Decuppio at the same observatory yet another. Similar observations were made by Scott and Wray in the summer of 1847; by Sidebotham and Lowe on March 12th, 1849; by Ohrt on September 12th, 1857; by Russell and others on January 29th, 1860; and by Lummis on March 20th, 1862.

All these observations seem to have been instances of round dark spots of nearly the apparent size of Mercury when in transit, or from 8″ to 15″ in diameter, so that they would indicate the existence of a planet from 4000 to 7000 miles in diameter. Such a planet would shine nearly as bright as Venus, and would be so distinct, especially during solar eclipses, that had it existed it must long ere this have been detected. Either, then, these observers very much exaggerated the dimensions of the object they saw, or it was not a planet in transit. If they were not deceived in thinking the bodies actually moved as they described them, then their observations would seem most perplexing. They might be comets, they might be gigantic meteors moving quite close to the earth, and in the same direction, with nearly the same velocity; but it is certain that they were not intramercurial planets.

Certainly not such planets.

FIG. 79.

There is, however, one of these observations which stands out from the rest. Shortly after Leverrier had announced his theoretical conclusions, a Dr. Lescarbault, a French amateur observer, sent him an account of an observation of the transit across the sun of a body which he regarded as that of an intramercurial planet. On March 26th, 1859, Lescarbault saw a small circular black spot, about 3″ in diameter, cross part of the solar disc, and egress from the sun at a determined time. Leverrier made an elaborate inquiry into this observation, and soon satisfied himself that it was genuine. Employing the data furnished by the Doctor's observations, he deduced the distance and elements of the orbit of the supposed new planet, which was named *Vulcan*. Arrangements were made to watch for it at the epochs of its next transits. Yet, though repeated searches have been made for it, this planet Vulcan has never been seen again. From Lescarbault's description, the real diameter of this planet must be about 1800 miles, so that it would under favourable circumstances shine like a star of the first magnitude; yet it has never been seen near the sun at the time of solar eclipses, though often looked for. It would seem, therefore, that either Lescarbault

Vulcan.

over-estimated the size of the body, or else it falls into the same category as the preceding observations.

It may be regarded as certain that if such intramercurial planets really exist, their actual diameter does not exceed 1500 miles, and is probably not greater than 1000 miles. Such bodies would, under favourable conditions, shine like stars of the second or third magnitude, and show bright little crescents about 3″ to 4″ in diameter, but when in transit across the sun be diminished by irradiation to tiny circular black points scarcely 1″ in diameter. They would thus be very difficult to detect *in transitu*, and would not be easy to discover except with a telescope even at the time of solar eclipses. Were their diameter less than 1000 miles, they would scarcely be visible in crossing the solar disc, and could only be detected with considerable trouble even during a total eclipse of the sun.

Probable nature.

If, then, there existed a ring of minor planets, in size and number resembling the great group which move round the sun in orbits lying between those of Mars and Jupiter, they would be too small to be detected when crossing the sun, and would be exceedingly hard to see even during solar eclipses, for the diameter of the largest of the minor planets does not probably exceed 500 miles, and most are much smaller. Leverrier's theoretical investigations would lead us to believe in the existence of such a belt, and if subsequent investigators confirm them, this belief will be much strengthened. It is true that a portion of the mass may exist in the form of the numerous meteor streams known to move round the sun, and which for a considerable portion of their orbit are within the orbit of the planet Mercury; but these cannot explain more than a small portion of the required mass, or they would disturb Venus as well as Mercury.

Zone of intramercurial minor planets.

But of late observations have been made which, whilst tending to confirm the supposed existence of a belt of minor planets within the orbit of Mercury, would also tend to show that some members of this group are much larger than the corresponding *extra-Martial* system. During the solar eclipse of 1878, Professor Watson, an American astronomer of considerable eminence, observed one or two brilliant star-like bodies near the sun, in places where no such stars are known to be. These bodies shone even in the glare as stars of the fourth magnitude, and appeared with rounded discs 3″ or 4′ in diameter. Their real dimensions would thus appear to be from 800 to 1000 miles in diameter, or practically twice the size of the largest known minor planet. Some uncertainty still attaches to these observations, for at some little distance away there were a pair of stars which might correspond to the objects seen by Professor Watson, if he had made some error in marking the position of the bodies seen by him, and had somewhat over-estimated their brightness.

Supposed observations of these planets.

Further opportunities must be awaited before this very interesting question can be settled.

XXV.

Numeral Adjectives (*continued*).

EXERCISE XXXV.—(*concluded*).

7. Un peintre (*painter*) à la douzaine est un artiste qui produit (*produces*) beaucoup et mal. 8. Le premier livre portant un millésime (*date*) fut imprimé (*printed*) à Strasbourg, en mil quatre cent cinquante-sept. 9. Charles sept avait fait épouser à son fils (Louis onze) Marguerite Stuart d'Ecosse, cette charmante princesse qui s'éprit d'un goût si vif (*took such a keen liking*) pour la langue et la littérature française, que trouvant un jour le poète Alain Chartier endormi (*asleep*) sur un banc (*bench, seat*), elle le baisa (*kissed*) au front, en présence de sa suite très étonnée (*astonished*), car il était très laid (*ugly*).—*Guizot*. 10. Félix Peretti fut élevé (*raised*) en mil cinq cent quatre-vingt-cinq au souverain pontificat sous le nom (*under the name*) de Sixte-Quint.

EXERCISE XXXVI.

1. We shall spend Passion-week *in* (at) Rome. 2. He spends his holidays *in* (at) London (*Londres*). 3. At (the) break of day they will pass through (*par*) Paris. 4. To-come like (*venir comme*) March in Lent means (*veut dire*) in French to-come incvitably (*inévitablement*). 5. To-look-for noon at fourteen o'clock, means in French to look for difficulties where there are none (*des difficultés où il n'y en pas*). 6. That man looks for difficulties where there are none. 7. She spends her time (*temps*) *in admiring* (to admire) the rising and the setting of the sun. 8. We *found* (have found) napkins (*serviette*, f.) at eighteen francs *a* (the) dozen, and table-cloths (*nappe*, f.) at ten francs *a* (the) piece (*pièce*, f.). 9. In the first place you will find that Erasmus (*Erasme*) had handled all the subjects which (*sujets auxquels*) Luther touched, and in the second place that he (*qu'il*) handled them as a scholar and not as an apostle (*en savant et non pas en apôtre*). 10 *I wish them to* (I wish that they may) arrive *on* the 1st or the 2nd *of* October. 11. Why should they not arrive *on* the 21st *of* September? 12. This book has three volumes (*m.*): give me (*-moi*) the second. 13. They will arrive in (*at*) Edinburgh (*Edimbourg*) *on* the 2nd *of* July. 14. How old is your grandfather?—How old should you say he was?—I should say (*lui donnerais*) *that he is* eighty or eighty-five.—Well, he is (*eh bien, c'est*) a nonagenarian. 15. And your grandmother?—She is close upon seventy. 16. What o'clock is it?—It is twelve or a quarter-past twelve; I am not sure (*je n'en suis pas sûr*), my watch is fast. 17. Louis XI. was thirty-eight years old, and *had been residing for the last five years* (was residing since five years) in the states of the Duke of Burgundy (*états du duc de Bourgogne*) when (*quand*), *on* the 25th July, 1461, he learned

(*apprit*) that he was king of France. 18. Give the ten of hearts; do not play trumps. 19. Francis I., Henry VIII., Charles V., and Pope Sixtus were (imp.) contemporaries (*François, Henri, contemporains*). 20. The Merovingians were (*perf. def.*) the first, the Carlovingians the second, and the Capetians the third dynasty of French kings (*mérovingiens, carlovingiens, capétiens, dynastie*, f., *des rois de France*).

The Pronoun—Theory.

1. In adhering strictly to the etymology of the term, one finds that the pronoun is a word which stands *for a noun*. [But as we have occasion to speak of ourselves and of those whom we address, words are required to designate ourselves and them; and thus—with reference to personal pronouns at least—we may say that the pronoun is a word which designates a person without the help of a noun; and with reference to possessive, demonstrative, relative, and indefinite forms, that the pronoun is the simplest expression of position, whether of persons or things.]

There are five classes of pronouns: personal, possessive, demonstrative, relative, and indefinite.

There are three classes of pronominal adjectives, or adjectives derived from pronouns: possessive, demonstrative, and indefinite.

2. Personal Pronouns.—These designate a person without the help of a noun; they further denote the position which any person or thing occupies relatively to the speaker.

There are three personal pronouns:

One for the first person, or person speaking: *here*;
One for the second person, or person spoken to: *near to here*;
One for the third person, or person (or thing) spoken of: *there*.

They all admit a plural number, but there is a distinction of gender for the third person only. It is to the third person that the usual definition of a pronoun—a word for a noun—fairly applies. When the personal pronoun appears in conjunction with the verb, it is called *conjunctive*; when it appears apart from it, or is mediately connected with it (as, *e.g.*, by a preposition), it is called *disjunctive*.

3. In any sentence the personal pronoun may be:

(i.) The subject or nominative of the verb.

(ii.) The direct object of the verb.

(iii.) The indirect object of the verb, with preposition *à* (to) understood.

(iv.) The indirect object of the verb, with preposition *à*, or any other preposition, expressed.

In the simpler constructions the pronoun will appear in the *conjunctive* form when it is a subject, direct object, and indirect object with *à* understood; it will appear in the *disjunctive* form when it is the indirect object to the verb by means of a preposition expressed.

(i.) The personal pronoun used as a subject, or nominative, to a verb.—Its forms are:

	Singular.		*Plural.*
1st person	... *je*, I	...	*nous*, we
2nd ,,	... *tu*, thou	...	*vous*, you or ye
3rd ,,	{ *il*, he, it / *elle*, she, it }	...	*ils* / *elles* } they

Remark I.—These may be placed before or immediately after the verb without any alteration of form: *je vois* (I see), *je ne vois pas* (I do not see), *vois-je?* (do I see?) *ne vois-je pas?* (do I not see?).

Remark II.—The pronoun *tu* is extensively used by those who stand on a very intimate footing. In prayer to God the Protestants use it for the sake of its austere simplicity; the Catholics use *vous*, as being in their eyes more reverential. Poets follow their inspiration. With the conventional *vous* it is indispensable to place adjectives and participles in the singular: Madame, vous êtes bien *bonne*; vous vous êtes *exposée* à la pluie pour moi; vous ne l'auriez pas fait pour vous-*même* (Madam, you are very kind; you exposed yourself to rain on my behalf; you would not have done it for yourself).

Remark III.—It is respectful on the part of servants to address their masters in the third person singular: *Monsieur veut-il? Madame désire-t-elle?* Not unfrequently gentlemen use the third person singular in speaking to a lady whom they do not know: *Madame, aurait-elle la bonté de me laisser passer*, Madam, would you kindly let me pass?

EXAMPLES.

JE bats le tambour, *I beat the drum.*
bats-TU la grosse caisse? *dost thou beat the big drum?*
IL joue du violon, *he plays on the violin*
ELLE ne joue pas de l'orgue, *she does not play on the organ*
NOUS pinçons de la harpe, *we play the harp*
pincez-VOUS de la guitare? *do you play the guitar?*
ILS sonnent du cor, *they blow the horn*
touchent-ELLES du piano? *do they play the piano?*
qui cherche le sifflet?—IL est ici, *who is looking for the whistle?—it is here*
quant à la guimbarde, ELLE est là, *as to the Jewish harp, it is there*
vos cliquettes?—ELLES sont dans votre poche, *your bones?—they are in your pocket.*

(ii.) The personal pronoun used as a direct object:—

	Singular.		*Plural.*
1st pers.	... *me*, me	...	*nous*, us
2nd ,,	... *te*, thee	...	*vous*, you
3rd ,,	... { *le*, him, it / *la*, her, it }	...	*les*, them.

Remark.—Whether the proposition be affirmative, interrogative, or negative, these pronouns are placed before the verb: *il me voit* (he sees me), *me voit-il?* (does he see me?) *il ne me voit pas* (he does not see me), *ne me voit-il pas?* (does he not see me?) The only case where they may appear after is with a verb in the imperative affirmative; and then one of them undergoes a change—viz. *me*, which becomes *moi*: *voyez-moi* (see me), but *ne me voyez pas* (do not see me). The other pronouns would suffer no modification; *te* as a strict personal pronoun cannot stand after the verb at all (we shall see what becomes of it as a *reflective* pronoun a little farther on). *Me*, thus changed into *moi* after an imperative affirmative, is one of the few examples of the disjunctive form in immediate contact with the verb.

EXAMPLES.

Paul ME comprend, *Paul understands me*
Jean TE battra, *John will beat thee*
Louis LE gronde-t-il? *does Louis scold him?*
Pierre LA punit-il? *does Peter punish her?*
Pauline ne NOUS aime pas, *Pauline does not love us*
Jeanne ne VOUS bénit pas, *Jeanne does not bless you*
Louise ne LES rend-elle pas? *does Louise not return them?*
voici le dé: LE prenez-vous? *here is the thimble: do you take it?*
voilà l'étoile: LA voyez-vous? *there is the star: do you see it?*
quant aux ciseaux, nous ne LES trouvons nulle part, *as to the scissors, we find them nowhere.*

IV.

Motion (*continued*).

Let us, to continue the subject of our last article, take the case of a cricket-ball. We will suppose it is thrown neither straight up nor along the level, but exactly midway between these two directions; and we will suppose it to be moving, at first, at the rate of 96 feet per second. In fig. 10 this initial velocity is represented by the line A B. Now, from experiment we learn (we shall have something more to say about this by-and-by) that the cricket-ball has an acceleration of 32 vertically downwards. This may be represented by the line B 1 (in fig. 10), drawn of proper length, 32, and in the proper direction — viz., vertically downwards. If now a straight line be drawn from A to 1, it will represent the velocity at the end of 1 second. The line A 1, you must remember, shows the *direction* in which the cricket-ball will be moving, and *how fast* it is moving. If you draw a figure for yourself, on a sufficiently large scale, you will find by measuring A 1 that the cricket-ball is moving at the rate of about 77 feet per second. If you want to determine how fast and in what direction the ball would be moving at the end of 2 seconds, or at the end of 3 seconds, you must draw B 2 (or B 3) just twice (or three times) as long as B 1, and *in the same direction* as B 1. When this is done, B 2 and B 3 represent the change of velocity in 2 and 3 seconds. The velocity at the end of 2 seconds will be found to be about 69 feet per second; at the end of 3 seconds it will be 75 feet per second. As to the direction, you will see from the figure that at the end of 2 seconds the ball will be rising a little, but that at the end of 3 seconds it will be coming down again.

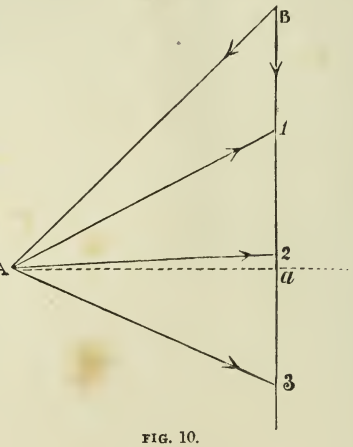


FIG. 10.

We can also answer by the help of this figure many other questions. For instance, how fast will the ball be moving when it has just got to the highest point of its course—that is, when it is neither rising nor falling? To answer this we have only to draw a horizontal or level line, A *a*. The distance from A to the line B 3 will give the required velocity, which you will find, by measurement, to represent a velocity of about 68 feet per second. We can also find how long the ball takes in rising. For the change of velocity is about 68 (the length of B *a*), and as the velocity changes 32 every second, the time required for a change of 68 is about $2\frac{1}{8}$ seconds.

In each of these examples we have supposed that the acceleration is the same throughout. Of course there are many instances in nature in which the acceleration changes, in which it gets greater and less, and changes its direction; but the consideration of these cases would carry us too far, and we must be content, for the present at any rate, to discuss only those in which the acceleration does not change.

Aids to study,

It is very likely that the subject of the present article, especially if new to you, will present some difficulty; but I think you will be able to overcome this with a little thought. You will find great help from drawing (not merely *copying*) the figures on a large scale, say $\frac{1}{8}$th or $\frac{1}{10}$th inch, to a velocity of 1 foot per second. When you feel pretty confident that you understand the matter, you should try some examples, such as the following: A body is thrown horizontally with a velocity 60. The acceleration is 32 vertically downwards. How fast, and in what direction, will it be moving at the end of 1, $1\frac{1}{2}$, 2, 3 seconds? How long will it be in attaining a velocity of 100 feet per second? In what direction will it then be moving?

§ 13. In the last section we considered only the question of how fast, and in what direction, a body moves, the initial velocity and the acceleration being given; but nothing was said as to where the body would be after such and such a time. This is the point we shall now discuss.

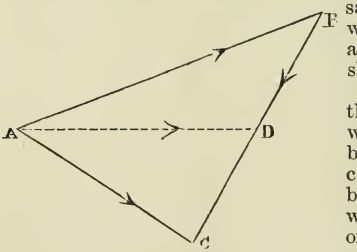


FIG. 11.

The "mean" of two velocities.

It will be convenient, in the first place, to explain what we are to understand by the "mean" of two velocities. If a body is moving with a velocity of 16 feet per second, and attains a velocity of 20 feet per second, its "mean" velocity is 18 feet per second. This is a velocity just midway between the two extreme velocities; the change of velocity from 16 to 18 is just the same as the change from 18 to 20; or, to put the same thing in other words, the change from 16 to 18 is just half the change from 16 to 20. Now, this is, for our purposes, the best way of finding the mean velocity of a body. The body has a certain velocity to begin with; and a certain change of velocity produces the final velocity; *half* of this change will produce the mean

velocity. For example, a body has a velocity 51 at first, and after a certain period it has acquired a velocity 79 in the same direction. Here the change of velocity is 28; half of this change is 14; so that the mean velocity is 51 + 14 or 65. The chief value of the rule is in its application to velocities in different directions. Suppose we require the mean velocity of a body, the original velocity being A B (fig. 11), and the final velocity A C. Here the change of velocity is B C; half this change is B D, if D is the middle point of B C; and

A stone is falling at the rate of 32 feet a second; it falls faster and faster, and at the end of one second it is falling at the rate of 64 feet a second. Where will it be then? In this case the extreme velocities are 32 and 64; and you will find without difficulty that the mean velocity is 48. The stone moving with this mean velocity for one second would go 48 feet; and we shall show in the sequel that this is the distance it actually falls.

A body is moving with a velocity of 10; three seconds afterwards its velocity is 40 in

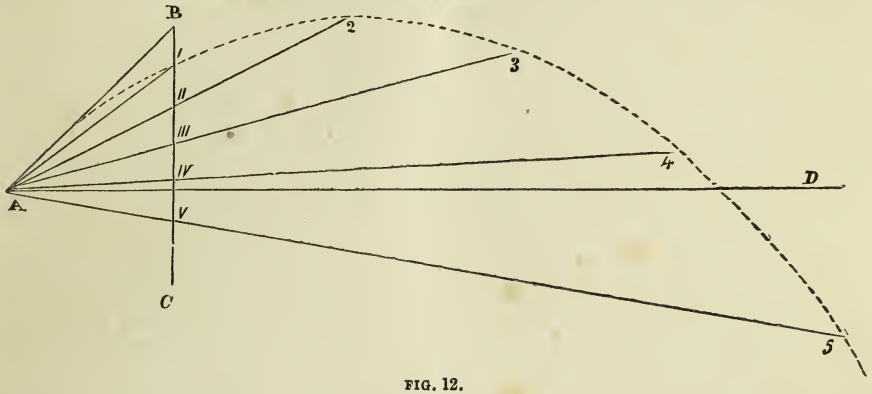


FIG. 12.

the mean velocity is A D. Or again, suppose we take the case of a body whose velocity at first is V and after t seconds becomes $V + ta$. The change here is ta; half of this change is $\frac{1}{2} ta$, so that the mean velocity is $V + \frac{1}{2} ta$. If this is not quite clear to you, compare it with fig. 11. A B may represent the original velocity, V; A C the final velocity; the change of velocity, ta, is represented by B C; $\frac{1}{2} ta$ by B D; so that the mean velocity, A D, which is the same as A B + B D, will be $V + \frac{1}{2} ta$.

The reason that I have dwelt upon this notion of the mean of two velocities is that it enables us very easily to answer the question we have set ourselves in this paragraph: Where will a body be after a certain time, if it starts with a certain velocity, and this velocity is continually being changed at a certain rate? The answer is this: Find the mean of the initial and final velocities; suppose a body to move *all the time* with this mean velocity; then it will come to just the same place as if it had been moving with the continually changing velocity. Before trying to prove that this is true it will be well to explain it by an example or two. When we understand the meaning of the answer, there will be less difficulty in proving that it is a right answer.

A question and answer.

the same direction: find its position. Here the mean velocity is 25. If the body were to move with this mean velocity for three seconds, it would go 75 feet; and this is the distance it actually does go when its velocity changes, as in the question.

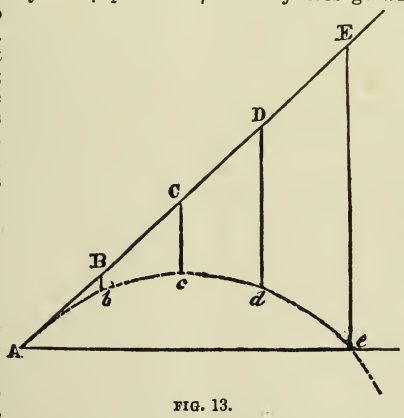


FIG. 13.

Let us take the example of the truck given on page 104, and find out how far it will go up the hill. Here the starting velocity is − 6; the velocity at the end of 3 seconds is 0; and the mean velocity is − 3. If the truck were to move with this mean velocity for 3 seconds it would go − 9 feet; that is to say, it would go 9 feet uphill.

Now find out where the truck would be at the end of 1 second and at the end of 5 seconds. In each case you will find that the truck is 5 feet up the hill. Let us see how this is. In the first second it goes 5 feet up the hill. In the first three seconds it goes 9 feet up the hill, and in the fourth and fifth seconds it comes 4 feet downhill again; so that at the end of 5 seconds it comes to the same place as it had at the end of 1 second. This will remind you that the question we have to answer is—Where will the body be? not—How far will it have gone? In the present example the truck goes 5 feet in 1 second, and 13 feet in 5 seconds; but it comes to just the same place, and accordingly we get the same answer to the question Where will it be?

Again, referring to fig. 11, let a body have a velocity A B, which is continually changing, until at the end of, say three seconds, it is represented by A C. The mean velocity is A D. To find where the body would be at the end of three seconds we must continue the line A D until it is just three times as long. Then the end of the line will represent where the body will be at the end of 3 seconds.

As a last example we will take the case of a cricket-ball thrown into the air as in the example on page 140, and we will try to draw the path it describes. In fig. 12 we represent the starting velocity, 96, by A B, the level line being A D. The acceleration, 32 vertically downwards, is indicated by the line B C. In one second the change of velocity is 32; half of this change is 16; so that if we make the distance from B to 1 equal to 16, A 1 will represent the mean velocity for the first second, and at the end of one second the ball will have come to 1. In two seconds the change of velocity is twice 32, or 64; half of this change is 32, and is shown on the figure by the line from B to ii; hence the mean velocity for the first two seconds is represented by the line from A to ii. Now, if the ball had moved for two seconds with this mean velocity, it would have come to the point marked 2, twice as far from A as ii is. In the same way we can find where it comes to after 3, 4, 5 seconds. If wanted, more points may be found: you can find where the ball will be after $1\frac{1}{2}$ seconds, $2\frac{1}{2}$ seconds, and so on. Now, if you join all these points by a curve—such as the dotted line in fig. 12—you will have, more or less nearly, a sketch of the path of the cricket-ball through the air. The more points you take, the better. Having drawn the curve to scale, you will be able to answer a whole series of questions. For instance, to find where the ball will come to the ground, you have only to draw a line representing the surface of the ground, and to measure upon your scale the distance from the starting-point to the place where the path of the ball meets the ground-line. Say the ground is level, so that it may be represented by the level line A D in fig. 12. Then the "range" of the cricket-ball is the distance A D, which you will find to be about 288 feet—not a bad throw. You can also find the time the cricket-ball takes to get from A to D. For the mean velocity is A *d*, *d* being the point where A D cuts the acceleration line. Now you will find that A D is about $4\frac{1}{4}$ times as long as A *d*; so that the ball would take $4\frac{1}{4}$ seconds. Or you may do it another way. The change of the mean velocity is B *d*, which measures about 68. But the mean velocity changes 16 every second; so that to complete the change 68, it requires $4\frac{1}{4}$ seconds, as before.

§ 14. These examples will, I think, be sufficient to indicate to you the full meaning of the answer I have given to the problem of this article. I will now show you how it is proved to be the right answer. For this purpose we will take the first example—a body moving with a velocity of 32, which in one second is changed to a velocity of 64 in the same direction. It will be a good exercise for you to apply the same method to the other examples, but this one will be enough to indicate the kind of proof. The body at first has a velocity of 32, and this becomes greater and greater up to the end of the second, when it becomes 64. Hence the body will move *more* than 32 feet in the second, for it would have gone so far if its velocity had never increased; and it will move *less* than 64 feet, because its greatest velocity would only just enable it to go that distance in the time. Let us now see how far the body goes in each half-second. In the first half-second it begins with a velocity of 32 feet a second, and finishes with a velocity of 48 feet a second. Hence it goes *more* than 16 feet, but *less* than 24 feet in this half-second. The other half-second it begins with a velocity of 48 feet a second, and finishes with a velocity of 64 feet a second—that is, in this half-second it moves *more* than 24 feet, but *less* than 32 feet. Taking the two half-seconds together, we find that the body moves more than 16 feet and 24 feet—that is, it moves *more* than 40 feet; but it moves less than 24 feet and 32 feet—that is, *less* than 56 feet. By taking each quarter-second separately, we get closer limits still. I will make a table of the distances (which you should find for yourself, as there may be a mistake in mine). The number of feet the body goes in the

1st qr.-second	is	more	than	8,	but less	than 10
2nd	,,	,,	,,	10	,,	,, 12
3rd	,,	,,	,,	12	,,	,, 14
4th	,,	,,	,,	14	,,	,, 16
whole second			,,	44	,,	,, 52

If you were to divide the time into sixteenths you would find that the body would go more than 47 feet, but less than 49 feet; if you divided the time into 64 equal parts you would find that the body must go more than $47\frac{3}{4}$ feet, but less than $48\frac{1}{4}$ feet. In all of these cases the limits get closer and closer to 48; *and* 48 *is always exactly midway between the two limits.* You will notice that here we cannot prove that 48 feet is the right answer; but we can prove that, if it is wrong, the error is smaller than any distance you can name. For instance, to prove that the error is less than 1 foot, you have only to divide the time into sixteenths; to prove it less than an inch, you would divide the time into about two hundred equal parts; and if you were to divide the time into a sufficient number of parts, you could prove that the error was less than the millionth part of an inch. Of course, no one has taken the trouble actually to do this, because there is a much shorter way of getting the result; but it will not be necessary to explain this method, as the above calculations will probably be enough to convince you of the accuracy of the rule. If not, I can only now refer you to other works where the subject is discussed at greater length.

Proof.

Some of my readers, who are acquainted with the elements of algebra, may like to have the results of this article put in the form of an equation; and I will do so, because from the equation we can

An equation.

derive another very instructive way of drawing the path of a body such as that in fig. 12. A body starts with velocity v, and has an acceleration a. We have already found the mean velocity of this body during t seconds to be $v + \frac{1}{2} t a$. Now, if the body moved with this mean velocity for t seconds, its distance from the starting-point would be t times $v + \frac{1}{2} t a$. Hence, if we put s for "distance from the starting-point at the end of t seconds," our equation is

$$s = t v + \tfrac{1}{2} t t a.$$

As we have already seen, this result tells us not only how far the body is from the starting-point, but also in what direction it is. The method of drawing the path of a projectile by the help of this equation is indicated in fig. 13. We first draw from the starting-point, A, a line whose length *and direction* are given by t v—that is to say, the line is drawn in the direction of the initial velocity, and its length is t v. From the end of the line thus drawn we draw another line, whose length and direction are given by $\frac{1}{2} t t a$—that is to say, the line is drawn in the direction of the acceleration a, and its length is $\frac{1}{2} t t a$. The end of this second line gives the position of the body at the end of t seconds. Say, for example, a ball is thrown in the direction A B, fig. 13, with a velocity 96, and we require its position at the end of 4 seconds. We first draw the line A E, in the same direction as A B, and make it 4×96 or 384 in length. Then from E we draw a line, E e, in the direction of the acceleration. If we suppose the acceleration to be 32 straight downwards, we should draw E e straight downwards, and its length would be $\frac{1}{2} \times 4 \times 4 \times 32$, or 256. The point e then shows where the body is at the end of 4 seconds. This method of drawing the path of a body whose velocity is uniformly accelerated will give you just the same result as the first method I gave you; it will be worth while for you to prove this by actually working out an example or two.

§ 15. There is a result of the equation that has been written above, which will be of very great use to us hereafter. If the body starts from rest, v is 0; and of course t times v is also 0; so that, *in this case*, the equation would be

$$s = \tfrac{1}{2} t t a.$$

Now, this shows that a body, starting from rest, goes in a given time a distance which is proportional to the acceleration; that is to say, if the acceleration is made twice, or three times—or, in fact, any number of times—as great as a, the distance will be made just as many times as great as s. Suppose we take 10 seconds for the "given time," then with an acceleration 1, the distance would be 50; with acceleration 2, the distance would be 100; with acceleration 3, the distance would be 150; and so on. To put the matter in another way, let us suppose a ball fixed upon a sloping plank, and another ball resting upon a steeper plank. If they are let go they will run down the planks, one quicker than the other. Now, if by trying the experiment you found that the second ball went, say, twice as far as the first in the same time, you would know that the acceleration of the second ball was twice as great. This is a point of very great importance, and will save us a good deal of explanation by-and-by.

§ 16. Let us take this opportunity of reviewing the work we have done. This should, indeed, be frequently done; but I must, for the most part, leave it to you, as space will not allow it here. We first spoke about the different kinds of motion, and explained how these motions might be divided into motion of rotation and passage; we also showed how two motions might be added together—that is to say, we found the result of two motions taking place at once. Then we considered how the quickness of a motion was to be measured. Just in the same way as we had dealt with change of place, we examined into the changes of velocity; first showing how these changes could be measured, and next explaining how to measure the quickness with which a velocity changes. This rate of change we called "acceleration." Had opportunity permitted, we might have treated of changes of acceleration; but we passed this by and assumed that the acceleration was unchanging or "constant." On this assumption, we showed the means of determining how fast and in what direction a body would be moving, and where it would be at a given time, if the initial velocity and the acceleration were known; and, incidentally, we indicated how many other questions might be answered about bodies whose velocity is uniformly changed. In all this we have been speaking of motion only. Nothing has been said of the body moving, nor of the circumstances under which the motions take place. With these we shall deal in the next division of our subject, which will be found comparatively easy by the student who has mastered the subject of this one.

Looking back.

V.

MONKEYS (*continued*).

Division into Old World and New World Monkeys.

A VERY simple and evident character divides the monkeys into two great series,—those which have the nose broad at the tip, and the nostrils at a distance from one another and opening sideways, and those which have the nose narrow at the end, the nostrils close together and opening directly in front. We receive an important view of the necessity of considering the geographical distribution of animals, when we learn that the broad-nosed forms are exclusively resident in the New World, and principally in South America, while the narrow-nosed live in the Old World, Europe, however, possessing but one species.

Characters of nostrils.

The American group must again be sub-

divided by separating the marmosets from the rest. These may be best represented as squirrel-like; they are small, thickly furred, long-tailed creatures, walking on all-fours. Like the rest of the American monkeys, they have not their cheeks dilated into pouches, and their sitting quarters are not hardened and destitute of hair.

Marmoset monkeys of New World.

In all the marmosets the fore-limbs are shorter than the hind-limbs—the reverse of what is found in many Old World monkeys, and in the spider monkeys of the New. The foot has the great toe very small, and slightly movable and opposable; the first finger of the hand has even less mobility, and cannot be used as a thumb; consequently this is a paw rather than a hand.

The marmosets have the same number of teeth as man and the Old World monkeys, viz., thirty-two; but in their development they differ from all other primates, for the milk teeth are twenty-four in number, thus including three grinders on each side, above and below. The brain is well developed, and its hemispheres project over the cerebellum very considerably.

BLACK-FACED SPIDER MONKEY.

The rest of the New World monkeys, like the marmosets, have tails, and in some, as the spider monkeys, they become very long, sensitive, and powerful, serving as important agents for climbing, seizing, and holding. All habitually walk on the four limbs, with the palms and soles downwards. The fore-limbs are the shorter, except in the spider monkeys. Both thumb and great toe can be freely moved, and more or less opposed to the other digits.

Other monkeys of New World.

The teeth are thirty-six in all, the additional four beyond those present in man being added to the milk teeth, so that there are three milk grinders, and the permanent set consists of three more grinders on each side, above and below. In other characters much variation is found in this group. The shape of the head and skull and the structure of the brain are especially variable. In the howling monkeys there is a large face proportionately to the brain-case, and the latter is more like an ordinary quadruped's, the joint between the skull and the spinal column being directly behind instead of being beneath the skull. In correspondence with this, the brain has small cerebral hemispheres, which hardly reach backwards to cover the cerebellum at all.

Howling monkeys.

The squirrel monkeys, however, have a small face in proportion, and the joint of the skull with the spinal column is beneath the skull and very little behind its middle, thus coming very near to man. Similarly, the cerebral hemispheres are long, and project backwards so far as to extend even beyond the cerebellum; yet, very curiously, the surface of the brain has its furrows and convolutions quite simple in comparison with man. So strange are the combinations by which a high structure in one respect is compensated for by a lower one in another feature, so that the whole organism has a very different level from what we might predict by looking only at particular parts.

Squirrel monkeys.

The Old World monkeys are classed together by the narrow partition between their nostrils which open more or less forwards, and by their teeth being the same number as in man—thirty-two. The milk set consists of two incisors, one canine, and two grinders above and below on each side; in the permanent set there are three larger grinders behind the teeth, which replace those of the first set. With these common characters a great variety of animals are grouped together, and we must at once pay attention to the contrasts between two strongly marked divisions.

Old World monkeys.

One series bears especial resemblances to humanity: its members carry their bodies inclined or nearly vertical, instead of horizontal. They are not quadrupeds in the ordinary sense, although when they move on the ground they rest a good deal of their weight on

The manlike apes.

the fore-limbs; this takes place in quite an unusual way, the hands being placed with the palm parallel to the trunk and looking inwards, and either the tips of the fingers or the knuckles of the bent digits lending support to the body.

Locomotion.

There is no tail—a great contrast to many of the monkeys; the portion of the back-bone corresponding to the tail is very short, and consists of but few vertebræ, which are enclosed in the common skin of the body. The portion of the spinal column above this, again, forming the keystone on which the haunches are supported, shows an approach to the human structure, having more individual bones or vertebræ entering into its composition. Similarly, the number of bones in the spine in the back part of the trunk is equal to, or only one more, than we possess, while the other apes have two more. Another man-like feature is, that the crowns of the grinding-teeth have the same patterns as in man. Gorilla, chimpanzee, orang, gibbon, are the chief names associated with the term "anthropoid apes," or those which approach man in structure.

Tail.

Backbone.

CHIMPANZEE.

When we contrast these anthropoids with the rest of the Old World monkeys, we find the latter to be truly quadrupeds, nearly always having a tail, which, however, does not constitute a fifth limb by which they can seize branches and swing themselves about. They are all distinguished by the possession of considerable bare patches of skin on their sitting-quarters. Nearly all of them have their cheeks much dilated, and forming pouches in which supplies of food can be retained. Their teeth are not in perfectly continuous rows; there is a space in front of the canine above, and behind it in the lower jaw.

The brain has features very comparable to those of the human brain. All the principal furrows and convolutions are essentially the same in both, and in all these apes, as in man, the cerebral hemispheres project backwards beyond the cerebellum or little brain. But there is great variety in the form and appearance of the brain-case, which is much longer in some than in others. In some also the face forms a large proportion of the entire head. While one series shows a smooth rounded forehead, but little prominent, others have enormously developed brow-ridges, overhanging the eyeballs. The junction of the skull and the spinal column is not so directly on the under surface of the head as in some of the New World monkeys, being generally situated in the hinder sixth of its base, and looking somewhat backwards as well as downwards.

Brain and brain-case.

Mr. Darwin says: "The resemblance of monkeys to man is greatly caused by the relative position of the features of the face. The eyes are arched over; they are separated by a long nose, the end of which in some is very human. . . . . The likeness is increased by the fact that anger, sorrow, pleasure, and satisfaction are displayed by the monkey by nearly similar movements of the muscles and skin, chiefly above the eyebrows, and round the mouth." It is also pointed out by Mr. Darwin in his well-known and most interesting work on "The Expression of Emotion in Man and Animals," that "The great power of movement in the scalp of the gorilla, of many baboons and other monkeys, deserves notice in relation to the power possessed by some few men, either through reversion or persistence, of voluntarily moving their scalps." On this subject the reader may also refer to Mr. Darwin's "Descent of Man," vol. i., p. 43.

Darwin on monkeys.

In stature the full-grown orang has been known to exceed 7 ft.

XXX.

THE VERB (*continued*).

§ 197. *Contracted* verbs.
§ 198. Simple conjugation.
§ 199. Subjunctive mood.

§ 197. The following verbs, most of them originally weak,* are now between the weak and the strong; there is a vowel-change in many of them, but it is from long to short of the same vowel,—the addition *de* or *te* in the

* A few that were once strong verbs have an asterisk affixed.

Old English weak forms, as in *hidde, fedde*, has been dropped; or, after labiate, sibilant, and liquid letters, f, v, s, l, n, r, etc., has changed into t. These are called *Contracted* verbs.

1. Change from long to short vowel.

Pres.	*Past.*	*Pass. Part.*
bereave	bereft	bereft
betide	betid	betid
bleed	bled	bled
breed	bred	bred
cleave	cleft	cleft
*creep	crept *delt*]	crept
deal	dealt [pron.	dealt
dream	dreamt, dreamed	dreamt
feed	fed	fed
*flee	fled	fled
feel	felt	felt
hear	heard	heard
hide	hid	hid, hidden
keep	kept	kept
lead	led	led
*leap	leapt, leaped	leapt
leave	left	left
lose	lost	lost
mean	meant	meant
meet	met *red*]	met
read	read [pron.	read
shoe	shod	shod
*sleep	slept	slept
speed	sped	sped
*sweep	swept	swept
*weep	wept	wept

2. No change in vowel-sound.

bend	bent	bent
blend	blent	blent
bless	blest	blest
build	built	built
burn	burnt	burnt
cast	cast	cast
curse	curst	curst
cut	cut	cut
dress	drest	drest
gild	gilt	gilt
gird	girt	girt
have	had	had
hurt	hurt	hurt
kiss	kist, kissed	kist
lay	laid	laid
lend	lent	lent
make	made	made
put	put	put
rend	rent	rent
rid	rid	rid
send	sent	sent
set	set	set
shred	shred	shred
shut	shut	shut
smell	smelt	smelt
spend	spent	spent
spill	spilt	spilt
thrust	thrust	thrust

3. Miscellaneous.

bring	brought	brought
buy	bought	bought
catch	caught	caught
clothe	clothed, clad	clad

Pres.	*Past.*	*Pass. Part.*
†dig	digged, dug	dug
†rot	(rotted)	rotten
†saw	(sawed)	sawn
say	said	said
sell	sold	sold
seek	sought	sought
†show	(showed)	shown
†stick	stuck	stuck
†strew	(strewed)	strown
†spit	spit, spat	spit
teach	taught	taught
tell	told	told
think	thought	thought
work	wrought (worked)	wrought (worked)

§ 198. **Conjugation.** (See § 187). We now give specimens of the conjugation of a *strong* and a *weak* verb in their simplest form; after that one conjugation showing all the usual tenses will serve as a model for all *active* verbs, while another will show the *passive* verb in its possible tenses.

The verb *to be* must also be set out on account of certain pecularities.

STRONG VERB—Shake.

ACTIVE VOICE.

INFINITIVE MOOD. To **shake.**

Verbal Noun and Present Participle, **shak***ing.*
Passive Participle, **shak***en.*

INDICATIVE MOOD.

Present Tense.

	Sing.	*Plural.*
1st pers.	I **shake**	we **shake**
2nd „	thou **shake***st*	you **shake**
3rd „	he **shake***s*	they **shake.**

Past Tense.

1st pers.	I **sh*oo*k**	we **sh*oo*k.**
2nd „	thou **sh*oo*kest**	you **sh*oo*k**
3rd „	he **sh*oo*k**	they **sh*oo*k.**

Future Tense.

1st pers.	I **shall shake**	we **will shake**
2nd „	thou **wil*t* shake**	you **will shake**
3rd „	he **will shake**	they **will shake**

SUBJUNCTIVE MOOD.

Present Tense.

1st pers.	I **shake**	we **shake**
2nd „	thou **shake**	you **shake**
3rd „	he **shake**	they **shake**

Past Tense.

1st pers.	I **sh*oo*k**	we **sh*oo*k**
2nd „	thou **sh*oo*k**	you **sh*oo*k**
3rd „	he **sh*oo*k**	they **sh*oo*k**

IMPERATIVE MOOD.

2nd pers.	**shake** thou	**shake** you.

WEAK VERB—Call.

ACTIVE VOICE.

INFINITIVE MOOD. To **call.**

Present Participle, **call***ing.*
Passive Participle, **call***ed.*

† The verbs with the dagger † were once weak, but parts of them have assumed strong forms. The weak parts are shown by ( ).

INDICATIVE MOOD.

Present Tense.

	Sing.	*Plur.*
1st pers.	I **call**	we **call**
2nd „	thou **call***est*	you **call**
3rd „	he **call***s*	they **call.**

Past Tense.

1st pers.	I **call***ed*	we **call***ed*
2nd „	thou **call***edst*	you **call***ed*
3rd „	he **call***ed*	they **call***ed.*

Future Tense.

1st pers.	I **shall call**	we **will call**
2nd „	thou **wil***t* **call**	you **will call**
3rd „	he **will call**	they **will call.**

SUBJUNCTIVE MOOD.

Present Tense.

1st pers.	I **call**	we **call**
2nd „	thou **call**	you **call**
3rd „	he **call**	they **call.**

Past Tense.

1st pers.	I **call***ed*	we **call***ed*
2nd „	thou **call***ed*	you **call***ed*
3rd „	he **call***ed*	they **call***ed.*

IMPERATIVE MOOD.

2nd pers.	**call** thou	**call** you.

§ 199. The student can clearly see the small amount of inflexion remaining in English verbs, by observing the endings and vowel-change printed here in *italics.*

In practical use the Subjunctive is gradually declining, because so many of the old distinctive inflexions are lost that the few remaining are frequently not understood, or are confounded with the indicative (compare the tenses above given). But a right use of the subjunctive is certainly an elegance of diction, though it may sometimes sound almost pedantic. Thus to say "I would not go if I *were* you," or "Tommy shall come if he *keep* well," or "whether it *be* rainy or fine is no matter," are all better English than the modern careless habit which would say "if I *was* you," "if he *keeps* well," "whether it *is* rainy," etc. As before explained, it is employed in the subjoined or dependent part of a complex sentence (§ 99, 175): "if he keep well" is a clause the meaning of which depends on "Tommy shall come"; thence it arises that the conjunctions proper to complex sentences are signs when the subjunctive should be employed. These are, *if, unless, lest, except, whether, though, that, provided, until, till, where, how, while,* etc. See § 207.

Examples :—

"*If* she *be* not fit for me."—*Old Song, Withers.*

"*If* the Lord *have* stirred thee up . . . but *if* they *be* the children of men."—1 Sam. xxvi. 19.

"*Except* the Lord *had* shortened those days no flesh shonld be saved."—Mark xiii. 20.

"Watch ye . . . *lest* coming suddenly he *find* you sleeping."—Mark xiii. 36.

"*Though* I *speak* with the tongues of men and of angels, *and have* not charity, I am become as sounding brass."—1 Cor. xiii. 1. (Here two dependent clauses are put in the subjunctive by the principal clause. To understand this better, reverse the clauses and substitute *if* for *and*, according to modern use: thus, "I am become as sounding brass, though I speak with the tongues of men and of angels, if [I] have not charity.")

Several other forms of the Subjunctive mood, besides those given in the following conjugation, may be made by the use of different Auxiliary verbs with the principal, as

Present.	*Past.*
I *may* give	I may have given
I *might* give	I might have given
I *would* give	I would have given
I *should* give	I should have given
I *could* give	I could have given

Each of these makes a *Conditional form* of the Subjunctive. In this case, as in that of Tense (see before, § 180) the student must study the auxiliary verbs, and in passing, consider whether his subjunctive sentence is formed upon an *auxiliary* of *tense* or of *mood.*

Should and *would* convey the same senses of permission or personal will, etc., as their relatives *shall* and *will*, used in forming the future tense. See § 184.

XXIX.

Manufacture of Iron.

Without pausing to consider former methods or processes differing from our own, employed in other countries, we will at once proceed to lay before our readers a brief account of the smelting or manufacture of iron as carried out in England. The ore, which is generally found in those formations known as the carboniferous series, and often in close proximity to our coal-fields, is the substance ferrous oxide or clay iron-stone. There are other ores of iron, but it will be sufficient, for our purpose, to select the one which occurs most commonly in this country. This is a dull reddish-brown or black substance, whose richness of quality—meaning, of course, the quantity of iron it contains—may be inferred from its weight. The process the iron ore undergoes is similar to the one to which chalk or limestone is subjected, heat being employed to drive off the carbonic acid. This is technically known as roasting. The oxide of the metal, thus obtained, is, however, far from pure, containing silica, clay, sulphur, phosphorus, etc. The next and final process is carried on in what is known as a blast furnace. This consists of a structure of fireproof brick, of sufficient strength and thickness to resist the tremendous degree of heat to be generated within it. Such structures are

Smelting iron in England.

Iron ores.

Roasting the ore.

The blast furnace.

often fifty feet or more in height, and the diameter of the interior, at the widest part, may vary from fifteen to eighteen feet. One of their most recent forms presents outwardly the appearance of an iron tower. Of the general arrangement of a blast furnace the subjoined illustration will give a better idea than any mere verbal description.

The furnace, as will be seen, is closed at the bottom, but the powerful blast required to maintain so high a degree of combustion is admitted by pipes termed tuyères. Being constantly fed or supplied with fresh material from the top, a furnace when once kindled often continues in working order for several years without cessation. In addition to the iron ore, coal or coke and limestone are introduced into the furnace, each of which plays an important part in the reduction of the iron ore. The first change that takes place, after the commencement of combustion, is the reduction of the ferrous carbonate to a mass of porous or sponge-like metallic iron, by the carbon monoxide generated in the lower part of the furnace. This gas is the same that we frequently see burning in our own grates with a pale blue flame. On coming into contact with the heated ore it effects its reduction by uniting with the oxygen, and then, having again been converted into carbon dioxide, passing off at the top of the furnace as an invisible gas. The oxide undergoes this change, however, before the heat is sufficiently great to bring the whole mass to a state of fusion. Gradually sinking, meanwhile, on account of its weight, it soon reaches a portion of the furnace where the heat is sufficiently great to fuse the metal, which, uniting with a portion of the carbon present, is converted into carburet of iron or cast iron. On finding its way to the bottom, in a molten state, the liquid metal is, from time to time, tapped, as it is called, and allowed to run out into moulds of sand, forming, when cooled, what is known as pig iron. Meanwhile, the limestone is taking part in the process, and uniting with the clay and silica present, forms an impure kind of silicate or glass known as slag, which, floating on the top of the molten iron, also in a liquid state, is allowed to escape periodically from an opening in the upper part of the furnace. When cool the slag presents the appearance of a black vitreous substance formerly regarded as worthless, or at best as available for making roads, but it is now cast into moulds and used for a variety of purposes in connection with building. We may remark, however, that cast iron is never quite free from silicon. The intense heat of the molten mass reduces the silica, and combines with a portion of silicon, the quantity of which, however, as well as that of carbon, varies very materially in different qualities of cast iron. Cast iron is of a grey colour, darker, however, and mottled when the carbon is present in the solid form. It is brittle, breaking with a crystalline fracture, cannot be welded, and fuses at a lower temperature than wrought or fibrous iron. The gases emanating from the top of a blast furnace are no longer allowed to escape into the atmosphere. They are collected in a kind of cowl, conveyed by a pipe to the lower part of the furnace, and burnt over again. The heat they contain is thus returned to the furnace instead of being wasted.

A furnace often kept working for several years.

The first change in the condition of the ore.

Action of the carbon dioxide.

Cast iron a carburet.

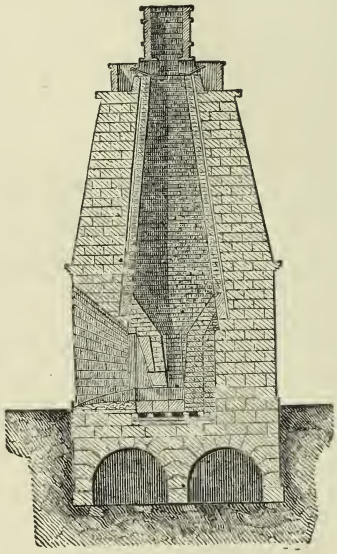
Pig iron.

Slag.

Silicon in cast-iron.

Attributes of cast-iron.

The gases from the furnace utilised.



SECTION OF BLAST FURNACE.

In order to convert cast into malleable iron it has to be melted again and exposed to a current of atmospheric air, in what is termed a reverberatory furnace; by this means the carbon, sulphur, silicon, phosphorus and other impurities, that may be present in the iron, are oxidized or burnt out of it. Lumps of iron are from time to time detached from the molten mass and exposed to pressure, by which the liquid slag, remaining in the iron, is squeezed out like water from a sponge. The iron is then hammered and rolled, and subjected to a variety of manipulations, by which it is made to assume the condition of wrought or malleable iron, a bar of which, instead of breaking short off with a snap like cast iron, exhibits a fibrous or cane-like fracture. The operations described above are known as fining and puddling.

Conversion of cast into malleable iron.

Fining and puddling.

The iron rendered tough or fibrous.

Steel, like cast iron, is a carburet of iron, but of course of far greater purity. If bars of the purest wrought iron are exposed to a red heat, in contact with carbon or charcoal, they will be found, after a certain time, to have undergone a remarkable physical change: they have become fine-grained instead of fibrous, and are more fusible than wrought iron. One of the most important and valuable attributes of steel is its capacity for assuming an extreme degree of hardness when heated and suddenly

Conversion of iron into steel.

cooled. The harder the steel, however, the more crystalline its structure.

Uses and qualities of steel. There are many varieties of steel, from the elastic watch-spring to the surgeon's lancet and the unyielding die used for engraving on, all of which are the result of different kinds of tempering. Let

Tempering. any of our readers mentally compare the kind of edge a knife made of wrought iron would bear with that of a razor or lancet, and he must acknowledge that steel is an invaluable material, whose loss could never be replaced by any other metal or alloy.

The celebrated Bessemer process, as it is termed, from its discoverer Sir Henry Bessemer,

Bessemer steel. consists in converting a mass of cast iron directly into steel by burning out the carbon and silica by passing a blast of atmospheric air through the molten mass. A quantity of cast iron is then added, sufficient to convert the nearly pure cast iron into steel, and the process is complete, the molten steel being forthwith cast

Rapid manufacture of steel. into ingots. The Bessemer process is exceedingly rapid, many tons of cast iron being by it converted into steel in twenty minutes. Such steel is chiefly used in the manufacture of rails for railway purposes, but can be employed for boiler plates and other portions of machinery.

When we reflect on the various uses of iron, and call to mind its unique and admirable qualities, we cannot resist the

The most useful of the metals. conclusion that we could better afford to lose all the other metals together than to part with this single one. No other metal has ever been discovered capable of supplying its place; and never, in the history of the world, has iron been employed so universally as in the present day, when the same material that furnishes the watch-spring and the steel pen is rolled into plates to defend the iron-clad or is welded into Krupp and Armstrong guns.

XXXII.

Derived Verbs with Distinct Meanings.

There are some Latin verbs derived from other verbs, which form distinct classes, according to their *sense*, not according to their *form*, of which the most important classes are these :—

I. The Frequentative Verbs, which express the frequent repetition or intensity of the action described. These are formed from verbs of the third conjugation generally, and pass into the first conjugation as follows—

canto, I sing often, from cano, I sing.
curso, I run often, from curro, I run.
regno, I continue ruling, from rego, I rule.
dictito, I say often, from dico, I say.
rogito, I keep asking, from rogo, I ask.
salto, I dance, from salio, I leap.

II. Inceptive Verbs, denoting the *beginning* of an action, are derived from verbs or nouns, and end in *sco*, which may be a form of *cresco*, and belong to the third conjugation, as—

senesco, I grow old, from senex, an old man.
puerasco, I grow into a boy, from puer, a boy.
mitesco, I grow mellow, from mites, mellow.
labasco, I begin to totter, from labo, I totter.
pallesco, I begin to grow pale, from palleo.
flavesco, I grow yellow, from flavus, yellow.
patesco, I grow open, from pateo, I am open.

III. Desiderative Verbs mark the *ardent desire* to do a thing. These are generally of the fourth conjugation, and end in *urio* (derived from *uro*, to burn), as—

esurio, I have an ardent desire to eat (from *edo*, to eat, *esum*, and *uro*).
parturio, I am in labour, from pario, partum.

IV. Deponent Verbs derived from substantives or adjectives denote an occupation, as—

Græcari, to play the Greek.
philosophari, to play the philosopher.
piscari, to play the fisherman.
furari, to play the thief.

These are of the first conjugation.

Self-Examination Questions and Exercises.

What are the four distinct classes of derived verbs with distinct meanings? Show to what conjugations they belong, and how each is found. Give examples of each class, and account for its formation.

Translate into English :—

Puellæ laudes heroum antiquorum patriæ cantant. Hi agricolæ per campos nostros ubique cursant. Multa cogitans per herbam saltaverat. Omnes senescimus et senectute labascimus. Quoties fur pallescit, si modo facta ejus mala patescent. Nemo pallescere sine justâ causâ potest. Poma in autumno mitescent. Nolite pallescere. Montes parturiunt, et ridiculus mus nascitur. Pueri esuriebant, quum poma dulcissime in arbore adspexerant. Me rogitare de tuis rebus adversis jam diù pudet. Nec utile nec justum est furari. Græcari perpauci Romani volebant, sed non facile poterant. Omnes sapientes philosophari divinam secundum legem oportet.

Translate into Latin :—

The boys cannot reach the apples which they eagerly desire to eat. Do not play the thief, unless you wish for punishment. They were not able to philosophise, though they much wished to do so. Sharpest cares grow soft in time. The citizens have grown old, since I saw them last. Do not run often through the lofty mountains beneath a burning sun. He keeps telling me all his misfortunes, although I did not often ask him about them. The nymphs kept dancing under the green boughs of the high tree. Cicero ought to have played the philosopher, and written many books concerning philosophy.

ON LIBERTY OF SPEECH.

BY THOMAS DUNMAN.

It is the boast of every Briton that he lives in a land

"Where, undismayed by friends or foes,
A man may speak the thing he will,"

but it is somewhat doubtful whether this liberty of speech is not occasionally carried so far as to degenerate into licence. It is undoubtedly a great thing to be able to speak one's mind upon things in general without the fear of being called into account for one's words, but there is a danger of occasionally forgetting that before *one* tribunal we shall be called to account "for every idle word."

Liberty implies two conditions which are sometimes opposed to each other—namely, the liberty of one's self, and the duty of not interfering with the liberty of others. The right to use our own freedom without any reference to that of other people would be no true liberty, but a licence worse than any tyranny. True liberty allows the exercise of each person's rights with due respect to the rights of others; but in speech it is too common to suppose that each individual has the right to say what he chooses, quite irrespective of the feelings and opinions of other people. To take an extreme case. In a company known to be largely composed of Quakers, some individual expresses himself very strongly on the folly of the doctrine of non-resistance. If remonstrated with, the individual, whom it is charitable to suppose is young, defends himself upon the ground that he has in this country perfect freedom of speech. The reply to this argument is, that in this country every one has liberty of speech, and therefore each individual must exercise his right with due respect to the rights of others; when these rights are interfered with, the boundary line between liberty and licence has been crossed, and the speaker is in error. An illustration of the way in which one man's right is limited by that of another is supplied by our law of property. The possessor of a freehold is said to have the right to consider as his own the space above his plot of ground "right up to the skies." Nevertheless, if he build a wall upon it, only twenty feet high, which interferes with his neighbour's light and air, down that wall will have to come. In just the same way the unwritten law says that each individual must not allow his liberty of speech to interfere with the rights of others.

A very common abuse of the liberty of speech is one which no doubt arises from ignorance and want of thought, and not necessarily from want of heart. We refer to the habit which some individuals possess of making unpleasant and uncalled-for remarks concerning the house, the furniture, the children or the horses of their friends or neighbours in their owners' presence. The right to criticise the belongings of others undoubtedly exists, but we have no right to utter our criticisms at such time and place as to wound the feelings of those whose the belongings are. The best way to meet such too-candid "friends" is to make similar remarks upon *their* belongings, and see how they appreciate the return of their own bad compliment.

An abuse of liberty of speech is often thoughtlessly committed by those who do not weigh their words before using them. Unmeasured abuse of some trifling error, and unmeasured praise of some deed deserving only of slight commendation, are far too frequently heard; but both are grossly unjust. To visit a slight offence with a heavy punishment is to distort and warp the moral sense, while to overpraise a good deed is to lower the standard of virtue.

Great injustice is frequently done by those who make fervent promises which they are unable to fulfil. This is frequently done from sheer good nature, accompanied by great want of thought. But this habit is often productive of cruel disappointment, which might be spared if the individual making a promise would always weigh well the meaning of the words he employs. Every one should cultivate the capacity to say "No" when absolutely necessary, quite irrespective of consequences; it is much better and much more honest to give a refusal than to make a promise which cannot be performed.

A most objectionable abuse of liberty of speech is committed when a person occupying a position of trust takes advantage of that position to spread abroad affairs which it is his duty to keep private. It cannot be too clearly impressed upon the mind of every young man that the business of his employers should be kept a secret, and that everything which comes to his notice in the office or the workshop he is bound to consider private matter, which he is not at liberty to disclose.

A similar breach of trust frequently occurs in the case of the affairs of friends. Some people seem to think that anything which is told them by a friend is necessarily matter for common gossip with the first acquaintance whom they meet. Such conduct is dishonourable in the extreme, and is productive of a large amount of suspicion and distrust. It should not be always necessary to enjoin strict secrecy on a friend before telling him about an affair which it is desired to keep from the public ear.

A very common interference with that liberty of speech which we all possess is seen in the case of an individual who monopolises the whole of a conversation, scarcely allowing any one else to utter a word. Some people who are by no means devoid of intelligence, and who are otherwise fitted to make agreeable companions, degenerate into bores simply from their inveterate habit of talking. Our great talkers, such as Dr. Johnson, Macaulay, and Carlyle, were men who took a large share in conversation, but who did not entirely engross it, eminently fitted as they were to do so. Moreover, these men when in company were

expected to talk, and their admirers hung upon their words, which were but too few to sate their appetite. Most constant talkers are far from great, and their superiority in genuine conversational powers is usually less apparent to others than to themselves.

An error which is akin to the one just referred to is the habit which some individuals have of silencing an opponent by sheer force of lungs. To roar an antagonist down when it was impossible to convince him was a practice to which Dr. Johnson was addicted, but it was a very unamiable blot upon a character not always faultless in respect to good taste.

It need hardly be said that to utter flattery is to abuse the liberty of speech, though it is an abuse not likely to cause a large amount of pain. Some folks have a habit, without in the least apparently deviating from the truth, of persuading others that they esteem them above all other members of the human family. This implied flattery is unworthy of an honest man, and is productive of great mischief. It is often the result of pure good nature, but it should be sternly repressed, and the tongue trained to express esteem and admiration without running riot and uttering words which exceed the meaning intended to be conveyed by them.

An abuse of the liberty of speech of an opposite character is the habit of detracting from a person's reputation or attainments while pretending to speak highly of them. This may be done in either of two ways. First there is the method of "damning with faint praise," as when you honestly praise some achievement, and some one else remarks that "it was very fair *considering*," when it was perhaps very good absolutely. Another method is by expressing pleasure in too weighty terms when some not very extraordinary feat has been performed. People who adopt this method express a surprised pleasure that "so-and-so should have done it," and probably add that the individual in question must have *greatly improved*.

Beyond those abuses of freedom of speech which are the result of mere thoughtlessness or carelessness, there are others which are due to much more culpable motives, but upon these there is no necessity to touch here. It will be sufficient if our readers are induced to keep a strict watch over that "unruly member" the tongue, and to see that while they exercise fully their right to say the thing they will, they may not interfere with the rights of others.

Of course there are occasions when it is not only the privilege but the duty of a man to speak out boldly and to have the courage of his opinions. In the presence of wrong and injustice, or when principles held dear are called in question, it is criminal to hold our peace, nor should we speak our mind in honeyed phrases. At the call of duty the honest man must speak out boldly, and must not mince his words, but let him endeavour to be sure that duty does call, and that his plainness of speech is not due to less worthy motives. The habit of "speaking our minds" arises quite as often from love of self as from a desire to benefit our neighbours.

BOTANY.

XXXI.

The Principal Families (*continued*).

The economic value of the order is in the case of the Leguminosæ commensurate with its extent. Not excepting even the palms, which are said tos upply every human need, the Leguminosæ may honestly be said to do so the most thoroughly of any plants. Food is furnished by those which are exemplified in peas, beans, and lentils, in their various kinds. Medicines are offered freely, as in the case of senna and the cathartocarpus. Timber is given, with resin, dye-stuffs, and various other substances useful in the arts. At times, also, we find poisons, sometimes fearful. As a decorative order, the pea family holds quite the foremost place. The meadows are fragrant with clover; the dry and sunward railway banks have golden patches of lotus bloom; the wild peas, purple, crimson, and yellow, make the hedgerows gay and pretty; and among the grass that waits for the scythe comes the lovely purple-tufted vetch, that seems not so much to have risen from the earth, as to be floating in the air. Every garden and greenhouse similarly teems with Leguminosæ. The lupines, in their many kinds, the sweet-pea, the everlasting-pea, the goat's-rue, are familiar to every one. Then among trees and shrubs we have the laburnum or "golden chains," the Robinia, the Wistaria, the common broom, the Spanish broom, the white Portugal broom, many species of Genista, Cytisus, and Caragana, in every case cheerful and engaging in their extreme floriferousness, which is emulated, all the while, indoors by the beautiful chorozemas from Australia.

The Cruciferæ.

The order Cruciferæ is constituted of plants having, as their name imports, a cruciform or cross-shaped corolla—*i.e.* one formed of four free petals, of exactly the same size and shape, and with long claws. Inside these are six tetradynamous stamens, surrounding a solitary ovary, with two short stigmas, which ripens into the fruit called a silique. The leaves are simple, though often deeply divided; they are alternate and exstipulate. The inflorescence is usually corymbose at first, changing by degrees into a long raceme. No better example of the order can be cited than the common cabbage or turnip of the kitchen-garden; or if something more dainty be preferred, the common stock or the common wallflower. A few exceptions occur, as in the candytufts, which have two of the petals much lengthened. Two or four of the stamens are occasionally undeveloped; and the fruit, in a good many, is destitute of the silvery partition, called the replum, which ordinarily divides it into two equal portions. The common radish supplies an example. No trees are found in this order, and only a very few of the species approach the nature of shrubs.

Herbaceous growth, such as we observe in mustard and cress, and the turnip and cabbage, is the almost universal rule. The order is widely diffused, but has its principal abode in the temperate latitudes of the northern hemisphere. Many representatives grow wild in Great Britain, but the majority are insignificant in appearance. Few families of similar extent are so devoid of anything hurtful or disagreeable. Not a thorn or a prickle, scarcely an instance of an offensive odour, nothing whatever that can be called poisonous, occurs among the Cruciferæ. On the contrary, they often furnish very valuable articles of food, both for man and the farmers' animals; they also give pleasant condiments and simple medicines; and when large enough to be employed for decorative purposes in the garden, they take their place in the front, and are in fashion always. To the names of the food-plants above mentioned may be added seakale, the watercress, and the cauliflower; among the condiments, in addition to mustard we find horseradish; the medicinal species are represented very strikingly in the scurvy-cress or cochlearia—a plant dispersed almost all over the world, and invaluable to sailors. The flower-garden. in early spring, is enlivened by the white bloom of the mountain-snow, *Arabis grandiflora*, by the yellow alyssom, and the inestimable wall-flower. Summer brings stocks and rockets, the former enduring till nipped by the frosts of late November; while in the meadows we have the delicate lilac of the Lady-smock, and the yellow Barbarea. Certain of the species inhabit the seashore, which they again help to decorate, none doing their part more genially than the purple sea-rocket, *Cakile maritima*, which sometimes blossoms anew in the depth of winter. Blue is a colour seldom plentiful in any order. In the Cruciferæ it is extremely rare. It is remarkable also that odour is very generally denied to the flowers, though when bestowed it is usually rich and aromatic.

FIG. 178—COTTON PLANTS.

Ranunculus, the genus which gives name to this large and important family, comprises the common buttercups of the fields, and in these we doubtless find the best characteristics of the order. The leading features are pentamerous flowers, with all the parts perfectly free. The sepals and petals usually drop away, sooner or later. The stamens follow them, and the pistils, if there be more than one, are in no degree coherent, except in the Nigella. The great mass of the family consists of herbaceous plants. A very few are undershrubby, and a few others, constituting the chief portion of the genus clematis, are ligneous climbers. These last are exceptional also in having opposite leaves, the rule being that these parts shall be alternate, or else radical. In no instance are the leaves compound, though often deeply divided; neither do they ever possess stipules, though the base of the petiole is frequently much dilated. The flowers are very often irregular. Sometimes they are destitute of petals, and the calyx is then usually enlarged and brightly coloured. The fruit consists either of achenia or of follicles. The complexion of the order is thus much diversified, yet after a little practice there is seldom any difficulty in recognizing any member of it. The temperate latitudes of the northern hemisphere supply the greater portion, but very few parts of the world are quite devoid of representatives.

The Ranunculaceæ.

The qualities and properties are such as to demand great caution in the testing. Some, such as the common purple aconite, or monkshood, are deadly poisons; many others are acrid or irritating—a character found in more than one of our native buttercups, and in two or three of the species of clematis. Scarcely one of them, on the other hand, can be said to be distinctly useful to mankind, except in so far as poisons are useful when employed as medicines. The interest of the order lies in the consummate beauty of at least two-thirds. Not to mention the gay yellow of the buttercups, or that of the marsh-marigold, in the woods and groves everywhere we have the chaste and delicate anemone. The globe-flower, the columbine, and the water snow-cups add further charm to country scenes; and in gardens the decorative character becomes, from Christmas onwards, almost unrivalled. The garden anemones, the Persian ranunculus, the pæonies, the larkspurs, keep up an unrelaxing flow of beauty for ten months out of the twelve.

The Malvaceæ.

In the very beautiful family named after the common mallow, *Malva sylvestris*, we have an example of one which, though abundant in the warmer parts of the world, is in England very slenderly represented. It is one of those again which peculiarly recommend themselves in being perfectly

free from anything deleterious, and in many cases of solid practical utility to man. The technical characters lie in extremely narrow compass :—the flowers are regular and pentamerous, the stamens hypogynous, very numerous, and united by their long filaments into a tubular column, which conceals the styles, the stigmas projecting at the head. The anthers are one-celled by abortion. The fruit is various, but almost always dry. The leaves are simple and alternate. The stature is very various, little weedy plants occurring at one extreme, while at the other there are trees of rather considerable dimensions. To this order belong the half-dozen species of the invaluable Cotton-plant, unique in the vegetable kingdom, in having its seeds covered with the delicate fibre the manufacture of which into calico has contributed so vastly to augment the wealth and the commerce of our country, though England has not yet outstripped India, the original seat of the arts of cotton spinning and weaving, in regard to the exquisite fineness and transparency of its muslins. Here, too, we find the marsh-mallow, celebrated in simple medicine for its mucilaginous properties; and several species which supply food to the inhabitants of tropical regions, the ochröe, *Hibiscus esculentus*, holding the foremost place. As a decorative order, the Malvaceæ may also claim to be distinguished. Every one is acquainted with the spires of the stately hollyhock, *Alcea rosea*. In gardens various species of Malva, Lavatera, and Malope, are also cherished, and in greenhouses and conservatories an equal number of species of the lovely genera Hibiscus and Abutilon.

The heather, which in autumn floods the hillsides with its delicate lilac; and the rhododendron, which in a thousand delicious varieties now enriches every garden in early summer, may be taken as the types of this exceedingly beautiful and attractive order. The two plants just mentioned, the heather and the rhododendron, certainly do not bear any very distinct external resemblance. They agree, nevertheless, in possession of those profounder characteristics which lock plants together, and thus furnish a capital lesson as to the nature of true botanical affinities. The Ericaceæ are, without exception, ligneous, though the shrubby forms are sometimes so diminutive as to trail upon the ground. The largest occur among the arborescent rhododendrons of Ceylon and the Himalayahs; and next to these come the arbutus, in its various species, and the tree-like heaths. Essentially the order is marked by its monopetalous four- or five-cleft corolla, with a small but definite number of hypogynous stamens, the anthers of which open by terminal pores. The leaves are simple, usually scattered or alternate, and very generally persistent throughout the winter. The fruit is usually dry and capsular, sometimes berry-like and more or less succulent. The great merit of the order consists in the loveliness and the profusion of the flowers, their long continuance, and endless diversity of hues—all colours being present in abundance, excepting only *blue*. Among the genuine heaths there are examples in the corolla even of a fresh and spring-like green. Hence the universal favour in which the Ericaceæ are held by cultivators. Stripped of their rhododendrons and azaleas, their Ledums and Kalmias and Gaultherias, our pleasure-grounds would now look bare indeed; and without its

The Ericaceæ.

FIG. 179.—PEONY.

Cape Ericas the conservatory would seem despoiled. At the Cape of Good Hope the genuine heaths have their principal home, existing there in the wild state to the number of probably 500 different kinds. The common purple rhododendron and the common yellow azalea come, on the other hand, from Asia Minor; while the fancy rhododendrons are mostly hybrids. No plant of particular economic value occurs in this family, which, after its delightful contributions to the general adornment of the earth, furnishes only a few trifling fruits, and material for the manufacture of domestic brooms.

The Caryophyllaceæ.

A very similar character is the abiding one of the beautiful order which receives its name from the fragrant carnation, *Dianthus Caryophyllus*. The species are, without exception, herbaceous, for the beautiful plant commonly called by florists and gardeners the tree-carnation is nothing more than the old-accustomed one of which Perdita speaks, trained so as to have an erect and comparatively lofty stem. As a rule, though unpretentious, they are pretty and graceful, contributing in no slight measure to the decoration of early and mature summer, but with this their value terminates. None can be said to possess any decided economic qualities. Saponine, the vegetable representative of soap, occurs in the plant (a native of our own country) thence called soap-wort, *Saponaria officinalis*, and in such plenty that the stems and leaves, if rubbed in water, furnish a lather in some degree available for washing. But nothing else can be named, and, as in many other cases, the loveliness of the flowers is the recommendation. The woods and groves are decked in May and June with the beautiful red lychnis or sylvan campion, *Lychnis dioica*. Later in the season, or towards hay-making time, every moist meadow yields the delicate and fragile Ragged Robin, *Lychnis Flos-cuculi*, which in Sweden opens its blossoms contemporaneously with the arrival of the cuckoo, whence the Linnæan appellation, and in England lingers till the *sweesh* of the scythe is heard, after which it is seldom seen. Later again comes the white evening campion, *Lychnis vespertina*, a kind of large edition of the *diurna*, but with petals the colour of milk. Meanwhile, upon every hedgerow, beginning soon after Easter, there are the myriad snowy flowers of the common Stitchwort, *Stellaria Holostea*, in rural districts called Snap-stalks and Break-bones, from the facility with which the internodes come apart. Upon the shore, all through the season, there is also the lovely white sea-campion, *Silene maritima*; and by searching it is easy to find a score of others, including Silenes, chickweeds, and the deep-red corn-cockle, *Agrostemma Githago*. In gardens there is a similar profusion—when they are gardens in reality, and not portions of surface sacrificed to "bedding-out"—of carnations, picotees, pinks of a dozen different sorts, always cheerful, and usually aromatic, with Silenes again, and lychnises, that keep up a delightful flow of bloom till nearly October. The botanical marks of the family lie in very small compass. The leaves are invariably opposite, simple, and undivided. The flowers are usually pentamerous, always regular, with both calyx and corolla; the petals and five or ten stamens free or hypogynous: the ovary superior, with two to five styles, and a free central placenta, to which are attached numerous seeds. The "placenta," in fruits or seed-vessels of every description, is the portion which actually bears the seeds upon its surface or margin. For it to be "free and central" is quite exceptional. There is no other family with hypogynous stamens in which it occurs, so that this one little circumstance is quite enough to distinguish the caryophyllaceæ. The seeds are very often most elegantly embossed, and should be collected for examination by every one who would enjoy the use of the microscope. The order is one of those which prevail especially in northern temperate latitudes, many of the species becoming alpine and even arctic.

IV.

Sources and Distribution of Wealth.

Labour is entitled to the first place, not only on the now commonly accepted economic doctrine that "labour is the source of wealth," but also for a comprehensive reason which shall here be put very shortly:—

"Out of labour comes capital, and out of capital comes cultivated and consequently rentable land."

Viewed separately, wages are the hire or payment of labour; profits are the return made to the savings of labour when put into bank, invested in stock or implements, or in employing and providing workmen with materials of work and means of subsistence; rent is profit of capital in another form,—the hire which the farmer agrees to pay the owner of land, and which varies with the productiveness of the farm. Labour is physical and mental exertion; capital is called "abstinence" because the capitalist abstains from the enjoyment of wealth, in order to produce more wealth by it; and land has usually been deemed property, as the labour or craft of the workman, or the capital of the employer or lender is his property.

Labour, capital, and land are found in the industrial system under the most various kinds of combination. The working man is sometimes his own employer, and owner of land, houses, or stock necessary to his industry. The yeoman or peasant-proprietor is owner of land and farmer in one. But if he happen to fall into debt, and desires to keep his land, he borrows money on a mortgage of the land, and the lender becomes entitled to an annual interest or share of the produce, which in another form would be rent or part of rent. The peasant-proprietor also hires labour, field

and domestic, as the large or small farmer does. But without attempting to enumerate the extremely diversified forms of co-operation between labour and capital in all free and civilised nations, it may be enough to observe that, in whatever form the co-operation may be or can be, the three returns or rewards are almost universally found,—viz., so much of the value of the produce or commodity due to wages, so much to profit of capital, and so much to rent of land or tenement.

How is rent of land determined?

The possession of land has, in all the older countries of the world at least, been an object of much desire and ambition; and has been surrounded with a more than ordinary amount of legislation, sometimes wise, and sometimes wholly unwise as well as unjust. Of late, indeed, the right of property in land has been wholly disputed by the communists; and, it must be confessed, the older economists rather assumed the right of property in land than attempted to trace the rightful foundation of what had not only been long established by law, but the subject of constant sale and resale like any other commodity. Property in land appears to arise out of the general fact that nothing whatever is of value until it is appropriated through discovery, or Government regulation, or other common law, to become the material of special industry, with its outlays of capital and labour. The more important question involved is thus not the right, but the *effect* of the right, and particularly the question whether the produce of land differs in the exchange-value it commands, or in the restraints upon that value exercised by the general principles of freedom of market and competition, from any other product of human industry.

Adam Smith, in various passages of his work, seems to see something of the nature of monopoly in landed possession as it was in his day; and this would almost imply that the landowners had a certain power of forcing their own terms. But Adam Smith wrote a hundred years ago, when there was yet no free trade, and but little transport from one part of the kingdom to another; and when territorial ownership had greater sway over all industries than it has now. Mr. J. R. McCulloch—a hard student both of Smith and Ricardo, as well as Malthus—while a staunch asserter of the principle that "labour is the source of wealth," says that rent is partly due to capital previously expended on the farm, and partly to the "natural and inherent powers of the soil."* But if these distinctions exist, it would seem impossible to separate them, or to say what is due to natural fertility and what to the capital outlays, that may or must have helped to make the natural fertility what it is. Bastiat was the first to grapple resolutely with the precise question under consideration, and in reply to Proudhon's "Property is Robbery," maintained that rent consists only of what is due to the improvement and building of the farm up to the period of occupancy, and that all natural agency of production passes out of exchange-value in this as in other cases.* The position of Bastiat is a sound-like advance in economic opinion, and it commends itself all the more to approval since, given the case of agricultural land, as in the United Kingdom, under effective competition with free supplies of agricultural produce from all parts of the world, it would be difficult to conceive, much more to discover, any element of cost of production returned in the market-value of our farm produce that is not contained in the farm produce of any other part of the world; or any instance in which there is a more free and effectual play of the competitive action of all the elements of production with each other, in the case of any other commodities, wherever produced.

* "Principles of Political Economy."

Leaving aside the legal abuses of conveyancing and the like, which are more a question of jurisprudence than of economic science, the rent of agricultural land in the case given is determined—(1) not by the will of the landowners, or by any power they can exert, but (2) by the free estimate of the tenant-farmers themselves. When a farm is vacant it is "put on the country." The tenant-offerers for the farm—proceeding on an experience which must be deemed the best, since it is their own interest that is immediately concerned—can only offer as rent a sum remaining over from an average market-value of the produce, repaying the wages of labour, and the profits of stock and capital, necessary to a successful cultivation of the farm. Rent thus retreats behind what is necessary to the wages of labour and the profits of farming stock and capital, and can only accrue after these have been satisfied on the basis of the rate of wages and the rate of profit in other occupations. Rent of land, when governed by economic principles, thus becomes one of the most rightful of incomes.

How is profit of capital determined?

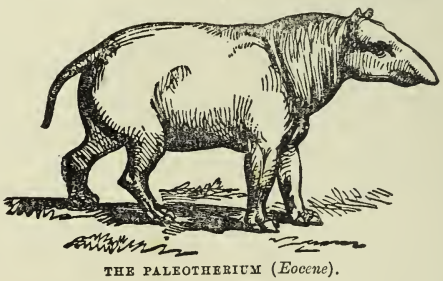
As capital will not go to the farming of land without the reward usually given to capital in other business, so neither will it go to any business in which the profit of capital is steadily declining, or is lower than the profit of capital in other businesses. So far as capital is free and disengaged, it seeks the higher profit, and by this movement reduces all exorbitant profits till an equal profit be again established. The profit of capital is thus mainly determined by the competition of capital; and the practical question in any country or at any time is whether this be an effective competition. "This condition," says Professor Cairnes, in the work already quoted, "is fulfilled in many industrial communities, completely in the case of capital, and less perfectly, but still within certain limits really and effectually, in the case of labour also." For details of this subject—the various forms and conditions in which capital is employed, and the causes of a rise or fall of profit, etc.,—the reader must be referred to the authorities, among which, besides the instructive passages of Smith on "profits of stock," and Mr. Mill's on the same subject, may be men-

* "Harmonies of Political Economy," of which there is an English translation by Patrick James Stirling, F.R.S.E.

tioned §§ 4 and 5 in the division "Distribution of Wealth," of Mr. McCulloch's work.

Between a man who has saved or inherited capital and a man who has nothing but his labour there is no common ground of comparison. The difference of the two situations is radical. Equity would seem to be fulfilled when the means of saving are open to one man as to another; and the rapid progress of means of saving, as well as of actual savings, among the working classes may be expected to cure many of the ills of a life of dependent labour. Nevertheless, it is important to see the exact position in which the working man stands in his naked relation to capital, or the to him necessary employer. Labour has its weak points, but it has also some strong ones. The wages of labour are definite, and they are advanced, whereas the profits of capital proceed on an estimate of future results, are postponed, and contingent; so that to discover the profits of capital strictly it would be necessary to take into account its losses, which is very seldom done. The profits only are seen: the losses simply disappear. Another strong point of labour is that capital can do nothing to gain profit, to increase itself, or to enjoy itself, without employing labour. A demand for labour is thus absolutely certain, wherever there is capital; but this demand has also its counterpart of supply, and the aggregate wages of labour can never be more than the aggregate capital seeking to employ labour. This co-equal fund will be divided more or less equally among the workmen in all the various branches of employment in proportion as labour is free to withdraw from, or at least not to increase in, employments where wages are lowest, and to pass into those in which wages are highest; almost precisely as in the case of profit of capital above shown.

How are wages of labour determined?



THE PALEOTHERIUM (*Eocene*).

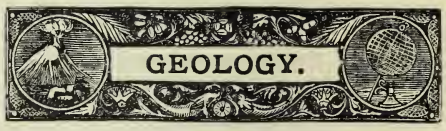
The doctrine that there is in every community an annual fund, determined by necessary causes to the employment of labour, is of old standing in political economy. It appears in Adam Smith,—"The demand for those who live by wages cannot increase but in proportion to the increase of the funds which are destined to the payment of wages," *—was further developed by Mr. J. S. Mill, wholly disputed by Mr. Thornton in his work on "Labour," modified or retracted by Mr. Mill, and again reinstated by Mr. Cairnes in his "Some Leading Principles." The reader would require to consult these authorities in order to embrace the conflicting grounds of the controversy—interesting enough in itself, but completely encircled and governed in its details by the fact above stated, though much overlooked by the disputants: viz., that capital can do nothing with itself whatever without employing labour, and must thus always in some sections or other of the industrial system be sustaining or increasing wages.

"Wages-fund."

All that seems necessary to add is that since, according to "the law of population," the number of workers is sure to increase, the employment of capital most favourable to labour and to wages is that which reproduces all the capital expended with an increase, and that the working man has thus a manifest benefit in the profit of his employer. And, *vice versâ*, an injury in his loss.

END OF "POLITICAL ECONOMY."

* "Wealth of Nations," Book I., c. viii.



XXV.

PREHISTORIC PERIOD.

WHAT is aptly designated the *prehistoric period* is not and cannot be sharply separated from the post-pliocene or pleistocene period on the one hand, or from the "historic" on the other. It is, nevertheless, an exceedingly convenient term, and sufficiently free from ambiguity if employed with due care. The history of our own islands may be said to commence with the invasion by Cæsar. Previous to that event they were but vaguely known to the then civilized world; history has but little to say respecting them, and that little is not so intelligible as could be desired. We know, however, that for a long period before the history of this country commences, Great Britain was inhabited by tribes who, although ignorant of the use of metal, were advanced beyond the stage of mere hunters. They had flocks and herds, tilled the soil, and had learned the arts of spinning and weaving. Their stone spear and arrow heads, knives, axes, and numerous other implements, are found in all parts of the country,—sometimes turned up in ploughed fields, sometimes found scattered over the downs and wolds, sometimes discovered in burial mounds, or in limestone and other caverns, some of which served them as places of habitation, and some as places of burial.

Prehistoric period.

We have thus an earlier "stone age" and a later "stone age"—that is to say, two periods when the inhabitants of this country, having no knowledge of metals, used only stone and wood and bone for their weapons and implements. For these two periods the terms "palæolithic" and "neolithic" are respectively employed. Palæolithic man lived in the pleistocene age, as described in our last chapter; neolithic man belonged

Neolithic men.

to a later though still remote era, before the commencement of history: between the two a lengthened period elapsed of which we know nothing. The traces of neolithic man have of late years been followed up with great care and skill by numerous observers: the caverns have been explored; their tumuli have been opened, even the localities where they encamped and manufactured their implements have, in many instances, been discovered and searched. One of the most remarkable places of this description is Cissbury, near Worthing. Here well-constructed earthworks, bearing an obviously Saxon name, have been ascertained, by excavations carried out by General Pitt Rivers and other gentlemen, to have been a neolithic encampment. Numerous slight depressions observable on the surface having been opened prove to have been pits sunk to reach the flint required for the manufacture of weapons and implements, worked by running narrow galleries along the lines of nodules. From these pits bones of animals thrown in with the rubbish with which they were filled up, and human remains, have been obtained. Similar pits, sunk to obtain good flint for working up, have been found elsewhere—as at Grime's Graves, near Brandon, in Suffolk, explored by Canon Greenwell. More commonly the men of that period appear to have been content to take the flint obtainable at the surface, or reached by very shallow excavations; and many spots may be found by the careful searcher, on our chalk downs, where the old men sat and struck off the sharp flakes required for knives, spear-heads or arrow-heads,—or chipped into shape the celts and other implements or weapons required for war or industry. A celt, it may be necessary to explain, is a stone axe, and is so called not because such implements were used by the Celtic tribes, but from the Latin word *celtis*, "a chisel." The stone axes of the palæolithic men were roughly chipped—those of the neolithic period are almost always polished.

Their encampments and implements.

There can be no doubt that the palæolithic tribes were very widely distributed over the surface of the earth; and the neolithic men have left the traces of their occupation in nearly every country on the face of the earth. They certainly spread over the whole of Europe in the remote times of which history has kept no record, but we are not quite sure whether we have of the peoples themselves any representatives still living amongst us. In our own country, at all events, it seems beyond question that the men of the neolithic age were small of stature, with long narrow skulls. So much has been learned by the examination of their remains; and Mr. Boyd Dawkins, to whom the world is greatly indebted for his labours in connection with this subject, advocates the view that in Wales, in the Highlands of Scotland, and in Ireland also, there are to be found to this day the descendants of the prehistoric races (neolithic) of whom we have been speaking. It is probable that as in modern times, so in the older periods, the most remotely situated tribes least accurately represented the civilization of their age, and there is reason to conjecture at least that the inhabitants of Great Britain were in culture somewhat behind their contemporaries on the Continent and in the far East, from which they were pretty certainly emigrants. Even in this country there might have been, and probably was, a difference between tribes occupying different parts of the land. They appear to have dwelt here also for a long period; long enough, probably, to make some progress in the ruder arts of the earlier stages of civilization; and all these and many other considerations have to be taken into account in attempting to form a conception of the men of the neolithic age. The following sketch from Mr. Boyd Dawkins' "Early Man in Britain" gives what is probably a very fair idea of the condition of neolithic man under the most favourable conditions. It is, of course, based upon a large collection of facts, obtained from many sources.

Wide distribution of the men of the stone ages.

"If we could in imagination take our stand on the summit of a hill commanding an extensive view, in almost any part of Great Britain or Ireland in the neolithic period, we should look upon a landscape somewhat of this kind:—Thin lines of smoke, rising from among the trees of the dense virgin forest at our feet, would mark the position of the neolithic homestead, and of the neighbouring stockaded camp which afforded refuge in time of need; while here and there a gleam of gold would show the small patch of ripening wheat. We enter a track in the forest, and thread our way to one of the clusters of homesteads, passing herds of goats and flocks of horned sheep, or disturbing a troop of horses, or small short-horned oxen, or stumbling upon a swineherd tending the hogs in their search after roots. We should probably have to defend ourselves against the attack of some of the large dogs, used as guardians of the flock against bears, wolves, and foxes, and for hunting the wild animals. At last, on emerging into the clearing, we should see a little plot of flax or small-eared wheat, and near the homestead the inhabitants, clad some in linen and others in skins, and ornamented with necklaces and pendants of stone, bone, or pottery, carrying on their daily occupations. Some are cutting wood with stone axes with a wonderfully sharp edge, fixed in wooden handles,—with stone adzes and gouges, or with little saws, composed of carefully notched pieces of flint about three or four inches long, splitting it with stone wedges, scraping it with flint flakes. Some are at work preparing handles for the spears, shafts for the arrows, and wood for the bows or for the broad paddles used for propelling the canoes. Others are busy grinding and sharpening the various stone tools, scraping skins with implements ground to a circular edge, or carving various implements out of bone and antler with sharp splinters of flint, while the women are preparing the meal with pestles and mortars and grain rubbers, and cooking it on the fire, generally

State of culture of neolithic tribes.

outside the house, or spinning thread with spindle and distaff, or weaving it with a rude loom. We might also have seen them at work at the moulding of rude cups and vessels out of clay which had been carefully prepared."

Bronze and iron axes.

In the course of time bronze took the place of stone for implements and weapons, not only in Great Britain but throughout the whole of Europe. Other races came upon the scene, in some cases entirely displacing, and in others apparently absorbing their predecessors. Then the use of iron became known, and this metal had displaced the bronze in this country at the time of the Roman conquest.

Prehistoric Britain.

There is no positive evidence to show *how* the prehistoric men entered Great Britain. The migrations of our race into Europe have been from the East, and to the East have been traced the animals they brought with them; but whether the men of the later stone period found our island separated from the Continent on the south by the Channel, and on the east by the German Ocean, we do not absolutely know, and consequently we do not know whether they had to cross with the help of rude canoes, or found their way over land. Probably the neolithic tribes came before the British Channel was fully formed, and lived here long enough to see this country divided from France by the "silver streak" which poets talk about. They may have seen also some minor changes of level, but there have been no very important alterations since their advent in the physical character of the country, excepting those which have been brought about by the direct agency of man.

XXXII.

Study for Reading and Pronunciation.

German Version.

Ein Bärenführer aß sein Abendbrod.
ine barr'-en-fuer'-er ahss zine ah'-bend-brot

Sein Bär stand draußen angebunden. In
zine bearr stand drowss'-en an'-ge-bunden in

der Dachkammer spielten drei kleine
dare dach'-kam-mer speel'-ten dry kly'-ne

Kinder. Das jüngste war nicht mehr
kin'-derr dass yueng'-ste vahr nicht mairr

als zwei Jahre alt.
als tsvy yah'-re alt

Die Thüre flog auf. Es war der Bär.
dee tue'-re flohg owff es vahr dare bearr

Er hatte den Weg die Treppe hinauf
airr hat'-te dane vaych dee trep'-pe hin-owff'

gefunden. Die Kinder erschraken, und
ge-fund'-en dee kind'-errr er-shrah'-ken unt

jedes kroch in eine Ecke. Aber der
yay'-des kroch in i'-ne ek'-ke ah'-berr dare

Bär that ihnen nichts.
bearr taht ee'-nen nichts

Dann sagten sie: „Das ist sicher ein
dan zaach-ten zee dass ist zi'-cher ine

großer Hund." Sie streichelten ihn, und
grow'-ser hunt zee stry'-chel-ten een unt

einer von ihnen brachte eine Trommel, und
i'-ner fon ee'-nen brach'-te i'-ne trom'-mel unt

schlug darauf. Der Bär erhob sich
shlooch dahr'-owff dare bearr er-hop'e zich

auf seine Hinterbeine und begann zu
owff zy'-ne hin'-ter-by'-ne unt be-gann' tsoo

tanzen. Jeder von den Knaben nahm
tan'-zen yay'-derr fon dane knah'-ben nahm

ein Gewehr, und sie gaben dem Bären
ine ge-vairr' unt zee gah'-ben dame bearr'-en

eins, und alle marschirten: „eins, zwei, eins,
eince unt al'-le mar-sheer'-ten eince tsvy eince

zwei!" Und der Bär hielt sein Gewehr fest,
tsvy unt dare bearr heelt zine ge-vairr' fest

und marschirte auch. Es war prächtig.
unt mar-sheer'-te owch es vahr präch'-tich

Plötzlich ging die Thüre auf, und die
ploets'-lich ging dee tue'-re owff unt dee

Mutter der Kinder stand da. Sie war
moot'-ter dare kin'-der stand dah zee vahr

todtenblaß unt sprachlos vor Schrecken.
tow'-ten-blass unt sprahch'-lohss for shrek'-en

Aber der kleinste Knabe nickte mit
ah'-ber dare kline'-ste knah'-be nick'-te mit

dem Kopfe, ganz vergnügt und sagte,
dame kopf'-fe ganz fer-gnueght unt zaachte

„Wir spielen Soldaten!" Und dann kam
veerr spee'-len zol-dah'-ten unt dann kahm

der Bärenführer, und der Bär wurde
dare bearr'-en-fue'-rer unt dare bearr voor'-de

weggenommen. Und dies ist eine wahre
veck'-ge-nom'-men unt deess ist i'-ne vahr'-e

Geschichte.
ge-shich'-te

Study on the Cardinal and Ordinal Numbers.

Numerals in German are considered as adjectives; but while the ordinals are always declined like adjectives, of the cardinals only from ONE to THREE—ein, zwei, drei—are declined in the usual way. Thus we say
ine tsvy dry
Zweier
tsvy'-er
Freunde, of two friends (genitive), while in
froin'-de
higher numbers we use prepositions to indicate the cases, leaving the numerals unchanged. Thus—Die Namen von vierzehn Männern
dee nah'-men fon fearr'-tsayn men'-nern
wurden gegeben, the names of fourteen men
voor'-den ge-gay'-ben
were given.

The word cardinal (from the Latin *cardo*, a hinge) signifies the chief number on which others hinge or turn (as we have the four cardinal points of the compass). The ordinal

numbers (from the Latin *ordo*, rank) are those that denote the rank or position of a certain unit. Thus achtzehn, eighteen, is cardinal, the
acht'-tsayn
name of a number. Es iſt die achtzehnte
es ist dee acht'-tsayn-te
Seite, it is the eighteenth page. Achtzehnte is
zy'-te
ordinal, as showing the rank of the page, the order in which it comes.

We have first to speak of the Cardinal numbers. They are as follows :—

ein, eine, ein, or einer, eine, eines (eins), one
ine i'-ne ine i'-nerr i'-ne i'-ness einee'

zwei, two
tsvy

drei, three
dry

vier, four
fearr

fünf, five
fuennf

ſechs, six
zex

ſieben, seven
zee'-ben

acht, eight
acht

neun, nine
noine

zehn, ten
tsayn

elf or eilf, eleven
elf (seldom used)

zwölf, twelve
tsvoelf

dreizehn, thirteen
dry'-tsayn

vierzehn, fourteen
fearr'-tsayn

funfzehn, fifteen
fuennf'-tsayn

ſechszehn, sixteen
zech'-tsayn

ſiebenzehn or ſiebzehn, seventeen
zee-ben'-tsayn

achtzehn, eighteen
acht'-tsayn

neunzehn, nineteen
noine'-tsayn

zwanzig, twenty
tsvan'-tsich

ein und zwanzig, twenty-one
ine unt tsvan'-tsich

zwei und zwanzig, twenty-two
tsvy unt tsvan'-tsich

drei und zwanzig, twenty-three
dry unt tsvan'-tsich

vier und zwanzig, twenty-four, etc.
fearr unt tsvan'-tsich

dreißig, thirty
dryss'-ich

ein und dreißig, thirty-one
ine unt dryss'-ich

zwei und dreißig, etc., thirty-two
tsvy unt dryss'-ich

vierzig, forty
fearr'-tsich

fünfzig, fifty
fuennf'-tsich

ſechszig, sixty
zech'-tsich

ſiebenzig or ſiebzig, seventy [frequently
zeeben'-tsich zeeb'-tsich (the latter more

achtzig, eighty
acht'-tsich

neunzig, ninety
noine'-tsich

hundert, (one or a) hundred
hunn'-dert

hundert und ein, (a) hundred and one
hunn'-dert unt ine

hundert und zwei, (a) hundred and two
hunn'-dert unt tsvy

zwei hundert, two hundred
tsvy hunn'-dert

drei hundert, three hundred
dry hunn'-dert

tauſend, (a) thousand
tow'-zent

zehn tauſend, ten thousand
tsayn tow'-zent

hundert tauſend, (a) hundred thousand
hunn'-dert tow'-sent

eine Million, a million
i'-ne mil-lioan

achtzehn hundert (und), / *acht'-tsayn hun'-dert unt* / sieben und fünfzig / *zee'-ben unt fuennf'-tsich* } eighteen hundred and fifty-seven

(The first und is generally omitted : achtzehn hundert ſieben und fünfzig.)

ein Tauſend vier hundert, / *ine tow'-sent fearr hunn'-dert* / neun und achtzig / *noine unt acht'-tsich* } one thousand four hundred and eighty

Observe that the units always precede the tens. We do not say twenty-seven, eighty-eight in German, but seven-and-twenty, eight-and-eighty. Where the fraction *half*, halb, comes in,
halp
a special idiom is used. We say for an hour and a half, Andert halb Stunden, meaning
an'-dert halp' stun'-den
that one hour is to be considered as taken entirely, *the other only half;* two miles and a half would also be called dritte halb Meilen,
drit'-te halp my'-len
meaning that of the third mile only half is taken. But this phrase is only used in the units ; we should not say for fourteen miles and a half fünfzehnte halb Meilen, but
fuennf'-tsayn-te halp my'-len
vierzehn und eine halbe Meile. Einer, eine,
fearr'-tsayn unt i'-ne hal'-be my'-le
eines (more frequently contracted into eins) is used when the numeral is not followed by a noun : Da war nur ein Mann, there was
dah vahr noor ine mann
only one man ; da war nur einer, there was
dah vahr noor i'-ner
only one (the noun understood).

When speaking of the cardinal numbers merely as characters or figures, they are all considered as being of the feminine gender : as—Die Eins, the one ; die Zwei, the two ; die Drei, the three ; where, in every instance, the word Zahl (number) is understood ; thus die (Zahl) Zwei, the number two.

Hundert and Tauſend are frequently used as collective (neuter) nouns, and regularly inflected ; thus, singular nom. das Hundert, the hundred ; gen. des Hunderts, of the hundred, and so on ; plural nom. die Hunderte, the hundreds, etc. Million, million, is also made a noun (feminine).

XXVIII.

EGYPT (*continued*)

Middle Empire, from about 2000 *to* 1600 B.C.

WE know but little of the first four dynasties of this period, which are believed by Birch to have extended over about 436 years. The first monarch of the twelfth was Amenemha I. A papyrus in the British Museum records his hunting exploits, his conquest of the negroes, and the building of a palace.

Usertesen I., the successor of Amenemha I., had been associated with him in the government for some time before his death. The excessive overflow of the Nile, and was not only valuable in this way, for it became very rich in fish, which assured Egypt a considerable revenue. The Labyrinth, an immense structure stated to be for the reception of princes of the country, one of the marvels of Egypt, and of which now only a heap of ruins remains, was constructed by Amenemha III., who also built three pyramids, one of which was intended for his sepulchre. Little is recorded of the reign of Amenemha IV., beyond the working of the mines and the opening of new ones. A gap now occurs in Egyptian history in the interval between the twelfth dynasty and the expulsion of the Shepherds—a period said to have extended over nearly 1000 years. These Shepherds appear to have been an Arab or Semitic race, who overran and subjugated a part of Egypt, establishing their court at Memphis, and inspiring the Egyptians with

The Labyrinth.

The Shepherds.

THE PYRAMIDS OF GHIZEH.

records of this reign describe the wars with Nubia, which was partly conquered by Egypt, mention the extraction of gold from that country, and refer to periods of famine, and the stores of corn which were accumulated in Egypt. In the next reign, that of Amenemha II., we hear of a foreign arrival at the Egyptian court, which, as the individuals portrayed are of a Semitic type, has been considered to be a representation of the arrival of Jacob in Egypt.

Supposed representation of arrival of Jacob in Egypt.

Usertesen II. was occupied in holding Ethiopia in subjection during the thirty-eight years of his reign. That of his successor, Amenemha III., is celebrated for the construction of the stupendous lake Mœris, which was, in the time of Herodotus, 450 miles in circumference, and about 300 feet deep. It was constructed as a reservoir to store the the greatest horror and dread. The native kings were forced to retire to the south, where, being thrown in contact with Ethiopian rulers, they contracted foreign alliances. Finally they succeeded in expelling the hated Shepherds from the country, and re-established the ancient rule.

New Empire, from 1600 *to* 1100 B.C.

We have now to consider the kings from the eighteenth to the twentieth dynasty. The first of these is Aahmes, whose reign lasted twenty-five years, during which time he regained the sovereignty of Upper Egypt, establishing his court at Thebes. He then prepared an expedition against Ethiopia, and signally defeated the negroes. His warlike exploits over, he repaired and rebuilt the temples, which had fallen into neglect and disrepair. This monarch's queen, Aahmes-Nefertari, who reigned after him during the minority of his son, was

a negress. Amenhetp I., who ascended the throne very young, carried on war with Nubia, and made conquests there. On the monuments of this reign we see the horse and the wheeled car for the first time; previous to this the ass only was known in Egypt, being employed for transport.

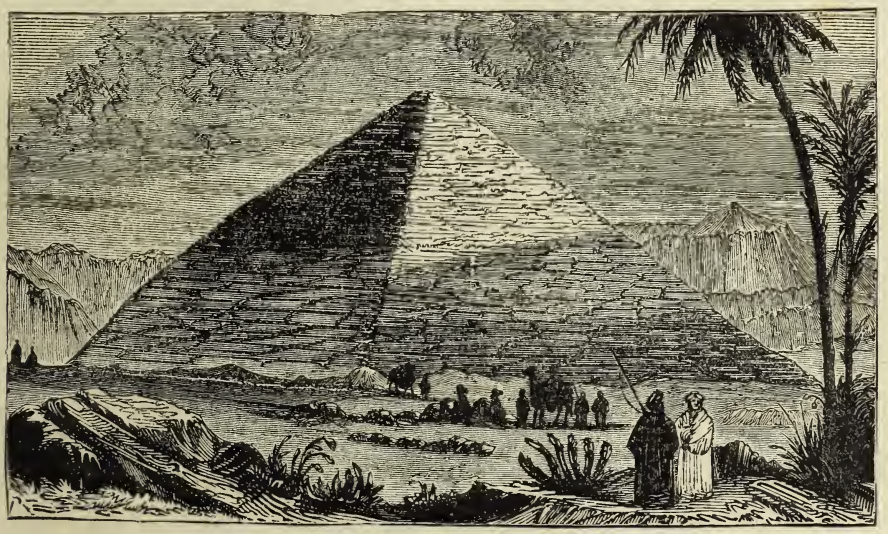
First appearance of horse and wheeled car.

Amenhetp reigned thirteen years. Thothmes I. was the next king, who carried on war with Nubia, attracted by the treasure of the country, such as ivory, gold, slaves, etc. Though warlike and valorous, he did not forget his religious duties, and continued the building of the great temple of Karnak. In this reign we hear of the Syrians for the first time.

Thothmes II. succeeded this king, and was associated on the throne with his sister Hasheps. He reigned ingloriously for a short time, and she continued alone. No records of battles or conquests distinguish her reign, but it is very interesting from the fact that an expedition was sent to Arabia Felix, in order to collect the products of the country. These were gums, spices, ebony, ivory, gold, emeralds, the skins of beasts, baboons, slaves, etc. A fleet of thirty-oared galleys carrying sails traversed the Red Sea successfully, and returned with the treasure. Hasheps also devoted much attention to the beautifying and building of the temples. Her name appears on several monuments, allied with that of Thothmes II., and afterwards she is portrayed as co-regent with her successor, Thothmes III.

Thothmes III.

The reign of this monarch was one of the most glorious of all the Egyptian kings. He was distinguished for his personal valour and bravery, almost to rashness. He undertook great expeditions against various nations, returning with numerous prisoners, sometimes counted by thousands, and much spoil. The conquered nations paid him tribute. Among that brought by the Ethiopians was the long-horned variety of domestic cattle; and the horns and tuft of hair on the head were, by artificial carving and plaiting, made to represent the fantastic device of the bust of a negro raising his arms as if in supplication (see Birch). One of the principal victories of the reign was won against the united Syrians and Mesopotamians, who were routed signally at Megiddo. Amongst the tributes of Syria we see on the monuments the picture of a cinnamon bear (*Ursus Syricus*), and stranger still, that of a young Asiatic elephant. As no elephants are found nearer than India, this seems to show that Syrian rule extended to that country. This monarch's reign lasted fifty-four years. Not only was he distinguished for the number and glory of his battles, but also for his navigation of the sea and great rivers, and finally for his taste for the fine arts, constructing magnificent temples and splendid architectural works. Amenhetp II., his successor, had a difficult task to perform. The pressure of the great conqueror having been removed, the Asiatic nations revolted, and had to be subdued. He is stated to have taken Nineveh, the present Kouyunjik.



BRICK PYRAMID.

The next king, Thothmes IV., is like his great namesake and predecessor in one thing only, — viz., his admiration for and construction of works of art, monuments, etc. His name is celebrated for his connection with the great Sphinx at Gizeh, though it is not supposed that it was he who erected this monument. It is certain, however, that a tablet discovered between the fore-paws of the Sphinx, and recording the embellishment of Thebes and Memphis, was the work of this king. He was succeeded by Amenhetp III., who appears to have been a mighty hunter and to have had a passion for the chase. He also took the field against Ethiopia, and mention is made of one great expedition in which over a thousand

The great Sphinx.

negroes were captured or killed. He was married to a foreign woman, Tii. He, like his predecessors, was devoted to architecture; several temples and two colossal statues are attributed to him. He attempted to introduce the worship of the solar orb into Egypt. His son, Amenhetp IV., who had been associated with him in his lifetime, tried to force on Egypt the worship of the sun-disk, which had been attempted by his father. It had previously been known in Egypt, but he carried it to the greatest extremes, and, prompted probably by his mother, the foreign Tii, he persecuted other forms of deities. Tribute was continued in this reign, so that the power of the king still continued over a part of Asia. He had no male issue. The reigns of the monarchs who succeeded Amenhetp appear to have lasted about thirty-four years; nothing of great importance occurred in their time, nor indeed in that of Horus, the last of the dynasty, though he made one campaign against the Ethiopians, which is recorded in sculpture, and built the fourth gateway of the temple of Karnak.

Worship of the Sun.

The first king of the nineteenth dynasty was Rameses I., whose reign is not of interest. His tomb exists at Thebes. His son Seti was his successor: his reign was long and glorious, being chiefly occupied with conquests. The Arabs, Syrians, Hittites (for the first time), Greeks, and many towns of Central Asia, besides Nubian and Assyrian tribes, are mentioned as having fallen to his arms. His tomb has been discovered, and his alabaster sarcophagus is now in Sir John Soane's Museum, in London.

Nineteenth dynasty.

Rameses II. succeeded Seti: his reign is of great interest on account of his being the Pharaoh of Scripture, who "knew not Joseph": the Hebrews are mentioned as being bitterly oppressed and in a state of utter slavery in his reign. He was the Sesostris of the Greeks. His victories were very numerous; one great campaign against the Hittites is celebrated in the works of the poet Pentaur. His reign was of great length, and in it he built a considerable number of temples and even entire towns, as well as other architectural monuments of remarkable splendour. One of his feats was the construction of a great wall on the eastern side of Egypt, as a protection against his enemies. The Hebrews were employed on two cities or fortresses in the neighbourhood (see Exod. i. 2). The obelisk of Luxor, now at Paris, was erected in Rameses II.'s reign. The power of Egypt reached its zenith in his time; after his death it gradually declined. Meneptah now succeeded to the throne. He was engaged in wars, and especially in one against the Libyans, whom he routed with great slaughter by the aid of his mercenaries. The Hebrews being now crushed and abused at every point, were ripe for the Exodus, which appears to have taken place in Meneptah's reign, so that he is the Pharaoh whose hardness of heart would not let the people go, and who was finally drowned in the Red Sea, with his army of chariots and horsemen. The direction taken by the Hebrews, and the exact spot where Pharaoh's army perished, is a disputed point, and not yet satisfactorily settled. Seti II., son of Meneptah, succeeded his father on the throne. He did nothing specially worthy of notice, though he is recorded as a conqueror on a tablet, and there is a statue of him in the British Museum. This dynasty was speedily closed by the joint reign of a king and queen, Siphtah and Tauser.

Slavery of the Hebrews.

Jewish Exodus.

Setnekht was the successor of Siphtah; his name is mentioned in the great Harris papyrus. His reign was a disturbed and riotous one, but he restored tranquillity, atoned for wrong, and punished ill-doers, so that he pacified Egypt, and was buried after a beneficent reign in the tomb of Siphtah. Rameses III., his successor, was a great warrior as well as legislator; he re-organized the country,—a measure which had become highly necessary on account of the foreigners established in Egypt. He carried on war with the Shepherds, the Asiatics, and the Mediterranean nations, taking many European prisoners. He also fought and conquered the Libyans; his architectural works were magnificent, and one of his feats was the construction of a great reservoir. He reigned thirty-one years, and was buried in a splendid tomb, which has been discovered, and the lid of his sarcophagus has been brought to England.

Rameses III.

His son Rameses IV. mounted the throne after him, but nothing particular is known of his reign, or of that of any of his successors, until the time of Rameses XII., the principal event of whose reign was the departure of the god Khons to the land of Bakhtan, in order to cast out an evil spirit from a princess of that country, the attempt of the king to detain him there, and his triumphant return.

V.

Matter. Laws of Motion, Force.

§ 17. By numerous circumstances each one is led to infer that there are other existences besides himself. These other existences are of different kinds: men, trees, rivers, shadows, warmth—and, in fact, almost everything to which we have given a name. They are not known to us save by the effects they produce upon us, their appearance, their resistance to pressure, and so on. We ascribe these effects to existence outside ourselves, independent of us; and to that group which makes itself known by its resistance, we give the name of matter. The resistance may be great, as in the case of a stone wall, or it may be so small as to be imperceptible without the aid of special apparatus; but wherever we find it we presume that matter exists. Some matter is such that you cannot change its shape

Matter.

without a certain considerable effort—as wood, or stone. Matter of this kind is called *solid*; and it is with solids that we shall have to deal in these articles. It should be noticed that in some cases solids submit to certain changes of shape with great facility: for instance a string or a piece of fine muslin can be bent without difficulty; but in every case there are some changes of shape which cannot be made (the string, for instance, cannot be made longer) without considerable effort. Other kinds of matter—such as water or air—change their shape with great facility. But even these matters offer the resistance we have mentioned above, though in a smaller degree. The resistance of the air, for example, will be felt by you when you move your hand rapidly through the air; or when you try to compress a quantity of air, by forcing down the piston of a syringe while the jet is closed by your finger. Gases, liquids, and solids all offer resistance to pressure, and all are included in the term "matter." On the other hand, light and darkness, heat and cold, have never been observed to possess this property, and they are not called matter.

Solid matter.

§ 18. A little observation leads us to the conclusion that matter has a tendency to come to rest. When anything is set in motion near the earth's surface, and is left without special means of keeping up its motion, it comes to rest sooner or later. And our inference would seem to be in accord with one of the conclusions of the modern science of energy. For instance, Balfour Stewart says, ("Conservation of Energy," p. 153,) "we are led to look to an end in which the whole universe will be one equally heated inert mass, from which everything like life or motion or beauty will have utterly gone away." Nevertheless, our conclusion "that matter has a tendency to come to rest" is erroneous, at any rate unless qualified. Indeed, this notion about matter was the great stumbling-block in the path of progress of mechanics; and it was not until it was thrust aside by Galileo and his successors that any real advance was made in the science. If we wish to succeed as Galileo did, we must examine somewhat closely this question of the rest or motion of matter. Look at a book lying on a table. It is at rest; but it is at rest because it is supported by the table. We know, indeed, that if we were to take it away from the table, and leave it unsupported, it would not remain at rest—it would begin to move. Here we have an example of a portion of matter (the book) being prevented from moving by the presence of *another* portion of matter (the table). See, too, what happens when we leave the book unsupported. It begins to move. But it does not move sideways and skim away out of the windows; it does not fly upwards and stick to the ceiling; it always moves downwards—it moves *towards the earth*. The result is so familiar that we pay but little attention to it, and fail to note its significance; but when we begin to ask why does the book *fall*?—why, when left unsupported, does it not move sometimes in one direction, sometimes in another?—when we ask these questions, we are led to the conclusion that the earth has to do with the motion; and we learn that matter (the book) is sometimes put into motion by reason of the presence of *other* matter (the earth).

Apparent tendency towards rest.

The attraction of the earth.

Let us now come back to our old friend, the cricket-ball. When this is thrown into the air, it is set in motion by other matter—the hand of the thrower. Its motion is observed to change; and it is also observed that this change is always towards the earth. This leads us to conclude that the earth is the cause of the change of motion, and we learn that the motion of one body (the cricket-ball) is changed by the proximity of *other* matter (the earth). Another instance is afforded by the motion of the earth round the sun. In the early part of the seventeenth century Kepler published the three "laws" which are known by his name. These laws expressed, in a very convenient form, all that was known about the motions of the planets round the sun. It was as if Kepler had made a map showing the paths of the earth and other planets, and showing also how fast they moved in the different parts of their orbits. With such a map it would be easy to find out how the velocity changed from time to time; and this was done, about two hundred years ago, by Sir Isaac Newton. He found that the change of velocity was greater when the planet was near the sun, less when the planet was farther from the sun; and it was always directly towards the sun. It is impossible to resist the conclusion that the sun is the cause of the change of motion; and here again we have an instance of the motion of matter being affected by the presence of *other* matter.

Kepler's three laws.

Sir Isaac Newton.

§ 19. Let us turn now to examples of a somewhat different kind. Drop a thin flat stone, or an oyster-shell, into a river or lake, and watch it as it sinks. Instead of falling straight down through the water, it will take a strangely erratic course. It skims to one side and then to the other, slowly sinking all the time. If the water were not there, the shell would fall straight; and we conclude that the water is, in some way, the cause of the curious motion just noticed. A feather allowed to fall will move very irregularly; but there is no difficulty in finding the cause of this irregularity. It is the air; for when the air is in motion, as in a draught or a breeze, the feather moves in quite a different manner; and in a vessel from which almost all the air has been removed the feather falls just like a stone.

Falling in water.

Many other cases might have been added to these, did our space permit; but they all point to one conclusion—viz., that the rest or motion of a body is determined not by itself, but by other bodies. Whether it begins to move or comes to rest—whether it goes faster or slower—whether it changes its course to this side or that—in each case the change is to be attributed to the presence of other matter, and we

A necessary conclusion.

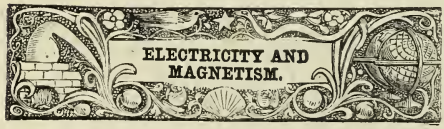
come to the conclusion that *matter, of itself, cannot change its own state of rest or motion.*

§ 20. This result cannot be proved by experiment. It is impossible to isolate a body—to remove it from the action of other bodies, so as to observe what will happen when it is left to itself. And even if this could be done it would be of no use, for we could not tell whether the body was moving or not, because, as was explained before, when we speak of motion we imply the presence of at least two bodies. It is vain, then, to ask for experimental proof of this property. It must be inferred from examples, such as those quoted above, which show that all changes of motion can be attributed to outside causes; and its truth is confirmed by the circumstance that all the conclusions to which it leads are found to be consistent with experience.

An experimental proof impossible.

§ 21. It is convenient to have a special name for the influence which one body exerts upon another, so as to affect its motion. We shall use the word *force* in this sense. You will notice that we have met with forces of two distinct kinds. One sort of force shows itself when the table prevents a book from falling (pressure), when a string is stretched by a weight (tension), when the motion of a feather is changed by the air through which it is falling (resistance), or when friction brings a body to rest. Forces of this class act upon the surfaces, upon the outsides of the bodies they affect; and the two bodies concerned are in contact. Forces of the other kind are exemplified by the attraction of the earth upon the body near it, the attraction of the sun for the earth, the attraction or repulsion between two magnets. In these cases the bodies concerned are at a distance from each other, and force affects the whole mass of the body; the inside of the body, as well as its surface, is attracted. But all forces agree in this—that they change the motion of bodies—and, as this is the only effect with which we shall have to deal, it will not be necessary further to insist upon the differences just noted.

Force.



VI.

Frictional Electricity (*continued*).

The principle upon which the action of the plate machine depends is precisely the same as that which governs the action of the cylinder machine. In both cases electricity is developed by the friction of a silk rubber upon glass, the two machines differing from each other mainly in the shape which the glass assumes.

Although more easy to make, and therefore very fully described in our last paper, the cylinder machine is not so good a form as the plate machine, which is an improvement made upon the former by Ramsden, in the year 1760.

As we have already stated, the first form of electrical machine consisted merely of a ball of sulphur which was turned on an axis and rubbed with the hand, and was invented about the year 1670 by Otto von Guericke, burgomaster of Magdeburg, to whom we also owe the air-pump. Subsequently resin was substituted for the sulphur; and finally by Hawksbee a glass cylinder was used, the hand still being employed as the rubber. Cushions of horsehair covered with silk were first employed as rubbers by Winckler in 1740, and in the following year Boze used an insulated tin-plate cylinder as a collector for the electricity produced by the machine. The next step in advance was the substitution by Ramsden of a glass plate for the cylinder, and the construction of the so-called plate machine, of which our diagram (fig. 18) represents a form which departs least from the original devised by its inventor.

Chronology of electrical machines.

Here a large plate of glass or vulcanite, A, is suspended between two supports by an axis passing through the centre and turned by a glass handle, M. D, D, are two quadrant-shaped flaps of oiled silk which pass from the rubbers, which latter are cushions fixed upon the inner side of the supports, so as to clasp the plate as it revolves, one pair being placed above and another below the axis. These cushions consist of pads of flannel fixed upon wood and covered with leather. The object of the silk flaps is to prevent the escape of electricity into the air. C, C, are two horseshoe-shaped rods of brass provided on their inner surfaces with a number of spikes. These rods are attached to the two prime conductors, P, P, which are supported on insulated legs, and are united at their ends opposite to the plate by a small rod, Q.

The plate machine.

It will be easily seen that this form of machine differs from the cylinder machine merely in shape, its details being varied only so far as is necessary to accommodate them to the altered form of the revolving glass.

The principle of the plate machine.

As in the case of the cylinder machine, the rubbers are connected with the earth by a chain, and when the plate is turned *it* becomes positively and the rubbers negatively electrified. By contact with the earth the tension of the negative electricity of the rubbers is reduced to zero. As the plate revolves the positive electricity upon it acts inductively upon the prime conductors, and decomposing their electricity, attracts their negative and repels their positive. By this attraction of the negative electricity to the points of the prime conductors, its tension there becomes so great that it can no longer remain on them, but passes across the air to the plate and tends to neutralize its positive electricity, while the positive of the prime conductors is left upon them, and (they being insulated), is unable to escape. In this manner a quantity of positive electricity accumulates upon the prime conductors, and they become electrified, not by the glass plate conferring positive electricity

upon them, but by that plate robbing them of their negative. If it is desired to obtain negative electricity from this machine instead of positive, it must be mounted upon insulating supports, and the prime conductors connected with the ground, when sparks of negative electricity may be obtained from the supports; and it is noticed that these sparks are sharper than those of positive electricity obtained in the ordinary way from the conductors.

The form of the plate machine just described is not the only one in use. A very good modification of Ramsden's machine, and one which is much more easily constructed by an amateur, is that known as Winter's, of which a diagram (fig. 19) will be given (see Article VII.)

Winter's plate machine.

Here, as will be seen, there is but one rubber, and the prime conductor consists of an insulated ball, to which are attached—so as to almost touch each side of the plate—a pair of rings furnished with spikes. The rest of the diagram will explain itself, and will serve as a useful guide to any one wishing to construct a machine of this kind. The chief advantage of the plate machine is that both sides of the glass are rubbed at once. In that form of it just described a large circular ring is frequently used, which very greatly increases the quantity of electricity accumulated. This ring, which is shown in fig. 20 (see Article VII.) fits into the ball of the prime conductor, and contains a metallic wire which communicates with the metal ball, as shown in the diagram.

A form of machine now very largely in use, and which we must by no means omit to mention, is the one shown in our next diagram, fig. 21 (see Article VII.), and was invented in 1865, by Holtz, of Berlin. Here two thin discs of glass or vulcanite are placed near together. Of these the larger, D D′, is fixed, and the smaller, A A, can be made to rotate on an ebonite axle, its rate of rotation being considerably increased by means of the two multiplying wheels, E, E′. The axle upon which A A′ revolves passes through a large hole in the centre of the fixed plate, D D′. In the same plate are also two other holes of somewhat triangular form, and in the lower edge of one hole or "window" and the upper edge of the other window are glued two pieces of varnished paper, P, P, with pointed tongues which project into the openings. These are the so-called *armatures*. The fixed plate is supported on insulators, as shown at Y′.

Holtz machine.

At the extremities of the horizontal diameter of the revolving plate, and opposite to the windows of the fixed plate, are two rows of metallic points or rakes, C, C′, which collect the electricity from the movable plate as it revolves between them and the fixed plate.

Connected with these rakes are two rods, R, R′, through the outer ends of which pass somewhat loosely the two smaller brass rods, terminated with knobs, B, B′, and having wooden handles, H, H′, by which the knobs may be moved so as to approach or recede from each other.

The principle upon which the action of this machine depends is the continuous inductive action of an electrified body,

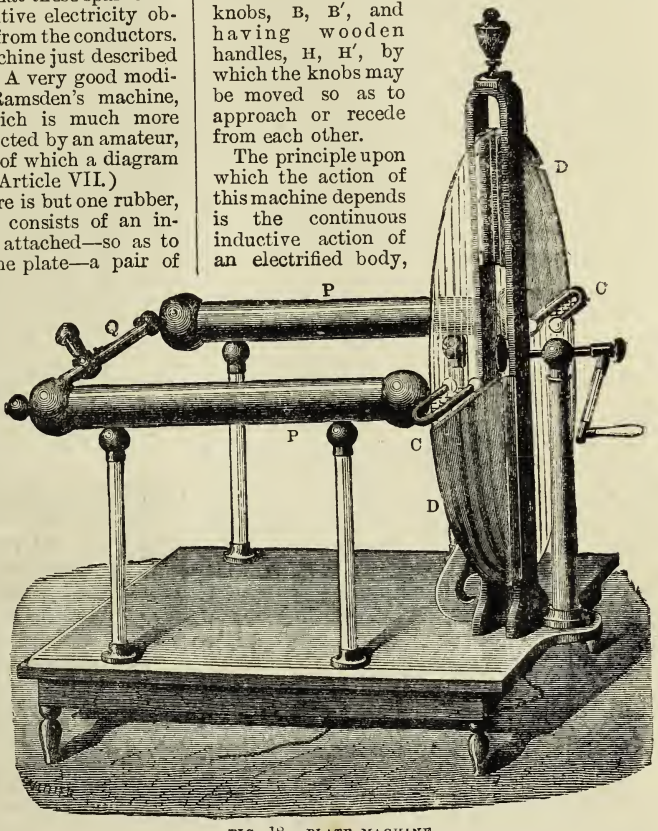


FIG. 18.—PLATE MACHINE.

as in the case of the electrophoros already described. Its theoretical explanation is not quite so easy of comprehension as that of the ordinary plate or cylinder machine, but a little patient attention on the part of our readers will enable them easily to master it.

Principle of the Holtz machine.

In order to set the machine to work it requires a small capital of electricity to work upon; and supplied with this, it speedily accumulates a very large stock in hand, which may be employed in any way desirable. The first thing to do is to connect the two knobs, B, B′, and this having been done, a sheet of ebonite, which has been electrified by striking it with catskin, is brought near one of the armatures, P for instance, and a few turns are given to the movable plate, A A′. Now the sheet of ebonite is, of course, charged with negative electricity, and this negative electricity, acting

How the machine is worked.

by induction on P, decomposes its neutral electricity, repelling its negative and attracting its positive. The negative electricity of the armature is discharged by its tongue on to the movable plate, and the armature therefore remains positively electrified, while the plate becomes negatively electrified. After half a turn of the latter its negative electricity is brought opposite to the other armature, P′, and acting by induction upon it, takes away a portion of its positive electricity and leaves it negatively electrified. In this way, after a few turns of the movable plate, both armatures of the fixed plate become electrified, one *positively*, the other *negatively*. This having been done, the electrified plate of ebonite is removed and the knobs, B, B′, separated. If the plate be now continuously turned, a perfect torrent of powerful sparks will pass between the knobs.

Now, we have already seen that when a conductor is submitted to the inductive influence of an electrified body, it becomes charged with opposite electricities upon its opposite surfaces. (See p. 73.) The same is also the case with non-conductors, only in them the separation of the two electricities is a gradual, not an instantaneous one. If, however, a bad conductor, such as a plate of glass or ebonite, be interposed between the source of electricity and a good conductor, the inductive action of the electrified body is somewhat modified. If, for instance, the source of electricity be positive, it is found that, *after a time*, the good and bad conductors are both charged with negative electricity on the side turned towards the source of electricity, and with positive upon their opposite sides. If, on the contrary, the inductive action is of only short duration, the influence is weak, and the glass plate then becomes charged with negative electricity on both faces.

Inductive influence.

Now, it will be remembered that the armature P is after a few turns of the plate *positively* electrified. When, therefore, the plate is made to revolve, the portion of it opposite to P will become *negatively* electrified, while at the same time the conductor R B, which has imparted its negative electricity to the opposite side of the plate A A′, has thereby become *positively* electrified. The glass plate continuing to rotate, that portion of it which just now was opposite P will soon be opposite the other armature, P′, which, it will be remembered, is *negatively* electrified. There will then be acting upon the other conductor, R B′, both the *negative* electricity of the armature and the *negative* electricity of the plate, and these acting together will withdraw from R′ B′ its *positive*, and leave it charged with *negative*. Now, therefore, we shall get both conductors charged, one with *negative*, the other with *positive* electricity. The portion of the plate opposite to the armature P′ will tend to keep the latter negative by withdrawing its positive, and will itself return to the neutral condition. By continued rotation of the plate A A′ the same phenomena are reproduced, and an accumulation of opposite electricities upon the opposite conductors takes place, and these unite to produce a spark which, with a good machine and under favourable circumstances, may reach a length of six or seven inches. In order to increase its power a pair of small Leyden jars is sometimes suspended to the conductors R, R′, the external coatings being connected by a rod with each other, and the internal coatings with the conductors of the machine. The effect of this machine is also much increased by doubling the number of plates.

Action of the armatures.

With either of the electrical machines which we have described, a number of very interesting and important experiments may be performed. Many of these we shall mention in the course of these papers on Electricity, and many others will doubtless suggest themselves to our readers; but in all cases it is desirable that experiments should be looked upon not merely as *amusing*, but also as *instructive*. Every one of these experiments has a meaning, which with the aid of the information given in these papers none of our readers need despair of comprehending, and we earnestly trust that they will endeavour to grasp to its fullest extent the meaning of the reply which Nature gives to every question with which, in the language of experiment, they attempt to ply her.

Value of electrical machines.

XXVI.

The Pronoun—Theory (*continued*).

(iii.) The personal pronoun used as an indirect object with preposition *à* understood :—

	Singular.	Plural.
1st pers.	... *me*, to me	... *nous*, to us
2nd ,,	... *te*, to thee	... *vous*, to you
3rd ,,	... *lui*, { to him / to her	... *leur*, to them

Remark I.—All these pronouns stand before the verb except when the verb appears in the imperative affirmative; then *me* is changed into *moi*, but the other pronouns are unaltered: *parle-moi, parlons-lui, parlez-leur*; but *ne me parle pas, ne lui parlons pas, ne leur parlez pas.*

Remark II.—The indirect objects *me* and *te*, as well as the direct objects *me, te, le,* and *la,* and the subject *je,* are elided before a verb beginning with a vowel or *h* mute: *j'aime* (I love), *tu m'humilies* (thou humblest me), *je t'autorise* (I permit thee), *nous l'admirons* (we admire him, her, or it), *vous m'avez parlé* (you spoke to me), *ils t'ont dit* (they have told *to* thee).

Remark III.—In phrases such as *we tell you, I give her, you* and *her* exactly correspond to this third position of the French personal pronoun, for the preposition *to* is here understood, just as *à* is understood in *nous vous disons* (*nous disons à vous*), *je lui donne* (*je donne à elle*). If all verbs had a corresponding government in both languages, this point would therefore present no difficulty; but the student must early bear in mind the fact that not a few verbs which govern *à* in French have a direct object (*are transitive*) in English, and that some English verbs which govern *to*, expressed or understood, have a direct object in French. For example: *répondre* (to answer) governs *à*. and therefore one should say *je leur réponds* = I answer *to* them; while I listen to them = *je les écoute*, as *écouter* is a transitive verb in French.

EXAMPLES.

il ME donne quelque chose, *he gives me something*
je ne T'envoie rien, *I do not send thee anything*
tu LUI rappelles quelqu'un, *you recall some one to him* (or *to her*)
vous ne nous recommandez personne, *you recommend no one to us*
VOUS dit-on rien? *who says aught to you?*
ne LEUR ferons-nous pas visite? *shall we not call on them* (or *pay to them a visit*)?

Remark IV.—It will be seen that the above examples contain none where *to it* or *to them*, referring to *things*, are illustrated. The reason is that although *lui* and *leur* may be applied to animals, and sometimes to plants, they seldom replace names of inanimate things; for which *y*—to be explained hereafter—is usually preferred.

(iv.) The personal pronoun used as an indirect object of the verb, with a preposition expressed :—

	Singular.	*Plural.*
1st person . . .	*moi*, me . . .	*nous*, us
2nd „ . . .	*toi*, thee . . .	*vous*, you
3rd „ .	*lui*, *him* . . .	*eux*, them, *m*
	elle, her . . .	*elles*, them, *f*

EXAMPLES.

il accourut vers MOI, *he ran to me.*
ce chien est à TOI, *this dog belongs to thee.*
je pense à LUI, *I think of * him.*
nous volons à ELLE, *we rush to her.*
courez avec NOUS, *run with us.*
allez donc chez VOUS, *do go home.*
tu pars sans EUX, *thou startest without them.*
qu'a-t-on contre ELLES? *what has one against them?*

Remark.—Here again no examples of *things* are given; the explanation is delayed. We should wish to impress on the learner's mind the necessity of mastering the facts exhibited by i., ii., iii., and iv. most thoroughly, before he attempts another step.

Practical Application.

VOCABULARY XV.

une aire, *barn-floor ;*	airée, *do. full of sheaves ready to thrash.*
un an, *year ;*	année, *the space of a year, a twelvemonth.*
une aiguille, *needle ;*	aiguillée, *needleful.*
une assiette, *plate ;*	assiettée, *plateful.*
le bec, *bill ;*	becquée, *billful.*
la bouche, *mouth ;*	bouchée, *mouthful (solids)*
le bras, *arm ;*	brassée, *armful, stroke.*
la chambre, *room ;*	chambrée, *roomful, mess.*
la charette, *cart ;*	charettée, *cartful.*
la cuve, *vat ;*	cuvée, *vatful*
la cuiller. *spoon ;*	cuillerée, *spoonful.*
la jambe, *leg :*	enjambée, *stride.*
le four, *oven ;*	fournée, *a baking-ovenful.*
la gorge, *throat ;*	gorgée, *mouthful (liquids).*
la hotte, *hod ;*	hottée, *hodful.*
le jour, *day ;*	journée, *the space of a day.*
la lèvre, *lip :*	lippée, *a mouthful (animals).*
le matin, *morning ;*	matinée, *the space of a morning.*
la maison, *house ;*	maisonnée, *houseful.*
le nid, *nest ;*	nichée, *nestful.*
le panier, *basket ;*	panerée, *basketful.*
la pelle, *shovel ;*	pelletée, *shovelful.*
la pince, *pincers ;*	pincée, *pinch.*
le plat, *dish ;*	platée, *dishful.*
la poêle, } *pan ;*	poêlée, } *panful.*
le poêlon, }	poêlonnée }
le poing, *fist ;*	poignée, *handful.*
le pot, *mug ;*	potée, *mugful.*
le soir, *evening ;*	soirée, *space of an evening.*

Remarks.—1. All the derivatives of the second column are feminine. 2. The affix *ée* (from L. *ata*), expresses the quantity contained in the primitive. 3. In the case of *année, journée, matinée, soirée*, as opposed to *an, jour, matin, soir*, a reference is made to some action occurring *in the course of*, or *lasting over the period of*, a year, a day, a morning, an evening: *il viendra dans l'année,—la journée,—la matinée,—la soirée* = he will come in the course of the year, etc. *Il passa les dernières années de sa vie à regretter les premières* = he spent the last years of his life in regretting the first. *Une journée* means also a day's work, a day's progress in travelling, a battle; *une matinée* means also a morning's work or performance; *une soirée* means also an evening's work, a performance, or party.

* *To think* governs *to*, not *of*, in French.

2. Revise the verb *finir*, and conjugate after it :

punIR, *to punish*	remplIR, *to fill*
gémIR, *to whine*	bâtIR, *to build*
applaudIR, *to applaud*	garantIR, *to warrant*
franchIR, *to cross*	fournIR, *to furnish*
saisIR, *to seize*	vieillIR, *to grow old*
garnIR, *to garnish*	rajeunIR, *to grow young again*
affranchIR, *to deliver*	périR, *to perish*

nourrIR, *or* donner la becquée *à* = to feed

EXERCISE XXXVII.

1. I punish you ; thou wast punishing them ; he punished me ; she will punish him. 2. This dog whines *the whole day long* (all the day = *toute la* —) ; he will not whine the whole evening. 3. We were applauding you ; you will not applaud us ; they would applaud me. 4. He crossed the distance (*f.*) in a few (*en quelques*) strides. 5. Do you seize me? were they seizing you by the (*à la*) throat? did we seize him? will he seize her? 6. I should garnish it (*m.*) ; I should have garnished it ; thou wilt garnish it ; thou wilt not have garnished it. 7. Let us deliver her ; let us not deliver her; deliver (*ye*) them ; do (*ye*) not deliver them. 8. Let him fill the vat ; let him not fill it ; let them fill the cart. 9. I wish (*désire*) *you to build a house for me* (that you to me may build a house) ; I *wish they would* (would wish that they might) build nests. 10. An armful of vine-branches (*sarments*) will not fill the oven. 11. I *seize your* (to-you seize the) arm ; seize my arm ; don't seize my arm ; the dog *was seizing his* (to him was seizing the) leg. 12. I was finishing my day's work; thou wast not finishing thy day's work. 13. We warrant to-you this watch (*cette montre*) for two years ; you warrant to-her a great success (*un grand succès*). 14. He finished it (*f.*) in three spoonfuls. 15. You will not fill *his* (to-him the) plate ; *will you fill her* (to-her will you fill the) plate? 16. You will *deliver* (furnish) to them two cartfuls of hay (*foin*). 17. She will grow old with him ; you grow younger every day (*tous les jours*). 18. Finish this mouthful of pie (*pâté*) ; do not finish this mouthful of wine. 19. He perished in (*dans*) the course-of-the-year, as (*comme*) his father had perished before (*avant*) him. 20. The birds (*oiseaux*) are feeding them (*tr. both ways*).

EXERCISE XXXVIII.

1. Est-ce à moi que vous parlez? Oui, et je vous prias de ne pas m'interrompre. 2. Lui
beg *interrupt*
as-tu dit que nous allons partir à l'instant?
told *set out* *immediately*
Oui, monsieur, et il vous prie d'avoir la bonté
kindness
de l'attendre. 3. Aimes-tu toujours la lecture?
wait for *still* *reading*

Oui, madame, quand je ne travaille pas, je lis
work
toujours pour me distraire. 4. Vient-elle de
amuse myself (*see vol. I, p. 236, c.*)
leur écrire? Elle m'a fait lire sa lettre. 5.
write *given to read*
Voulez-vous que nous lui écrivions ou que nous
wish *write*
lui parlions? Faites comme il vous plaira. 6.
do *will please*
Que leur as-tu fait? Je ne leur ai rien fait.
what *done*
7. Faut-il lui obéir? Certainement, s'il ne
must I *obey*
vous commande que ce qui est juste et sage. 8.
orders *but* *what* *right*
A qui les donnerai-je? Donne-les à Etienne.
whom *give* *Stephen*
9. Qu'est-ce que Julie vous a demandé? Elle
a demandé que je l'accompagnasse jusqu'à
accompany *as far as*
Genève. 10. Est-ce que tu ne me reconnais
Geneva *recognise*
pas? Non, je ne saurais dire qui vous êtes.
could *who*
11. Quand sa sœur l'a-t-elle quitté? Elle l'a
when *left*
quitté le six juin dernier. 12. Voyez-moi aussi
last *call upon* *as*
souvent que vous le pourrez.
often *as* *you can* (*do so*).

EXERCISE XXXIX.

1. Will you have us (*to*) speak to her?
(*v. 5th phrase of last Ex.*)
Yes, we will have you to speak to her. 2.
Did he tell you to leave immediately? No;
(*v. 2nd ph. of do.*) *de partir*
she told us to leave to-morrow. 3. Where
demain *où*
shall we send you? Send me home. 4. Do you
enverrons *envoyez* *chez moi* (*v. 5th*
wish him to buy it as early as to-morrow? 5.
ph. of do.) *achète* *dès*
Is he speaking to us? He never speaks to us.
(*after verb*)
6. Has Anthony given you those letters to
Antoine (*v. 4th ph.*) *ces lettres*
read? Alas! he has given me all his letters
hélas *toutes*
to read. 7. When did he ask you to do it?
quand *a-t-il demandé* *de faire*
He asked me to do it this morning at nine
ce
o'clock. 8. What did Lisette ask *her* (to-her)?
qu'est-ce que ———
She asked her nothing. 9. Has she just seen
(*before past part.*) (*v. 4th ph.*)
them? No, she has not just seen them. 10.
How could we have recognised *you* (thee)?
11. Thomas translated this pamphlet *for* (to)
——— *traduisit* *cette brochure*
you. 12. When will his sister leave him?
quand *sa* *quitter*
She will not leave him before Candlemas.
(*v. Voc. XV.*)

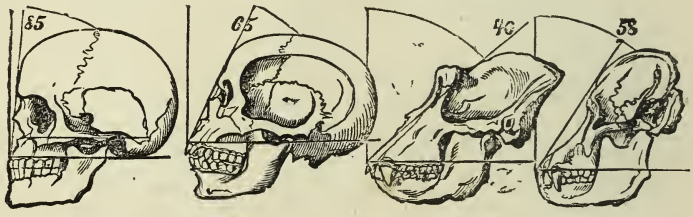
ZOOLOGY.

VI.

THE GORILLA.

HAVING now given a general account of the distinctions and chief variations to be found in the highest order of mammals, we proceed to refer as space may allow to the individuals composing the order. Here it is that the greatest charm of natural history lies to the general reader. We want to gain an idea of the animal as a whole, as it lives and moves; to get an acquaintance with it as much as possible like our acquaintance with a dog or a cat; to study its nature, its habits, its surroundings, its mode of rearing its young. We are persuaded that a deeper interest in zoology will be imparted by dwelling on a number of noteworthy species, and especially those most related to man, than by an attempt to condense all the information we have about animals into a series of general statements.

Individual histories instructive.



CRANIA EXHIBITING THE FACIAL ANGLE OF MEN AND MONKEYS.

To begin with the Gorilla, an inhabitant of the forests of tropical western Africa, let us notice first his most distinctive qualities, and then study his personal history. He is a creature of manlike stature, readily assuming the erect position. His spinal column has very much the same curves as that of man. He has thirteen pairs of ribs, being one pair more than we have. The upper limbs are much longer than the lower, and the upper arm greatly exceeds the fore-arm, unlike that of mankind. His brain has the greatest bulk and weight of any of man's neighbours. The shape of the stomach, again, is a feature in which these two resemble one another closely.

Striking features.

It is near the Gaboon river, a few degrees south of the equator in western Africa, that the gorilla is best known. The name of the animal is adopted from the records of Hanno the Carthaginian, who made a voyage of discovery along the African coast some centuries before the Christian era. The creatures to which he gave this name he considered to be a race of wild men, and it is by no means certain what they really were. Vague and magnified reports of the size and ferocity of the manlike inhabitants of the Gaboon forests were brought to Europe by travellers and traders in modern times, and it appeared that

History.

Hanno.

the natives considered them to be related to themselves, or that they were possessed by departed human spirits. Dr. Savage was the first who obtained some accurate knowledge concerning the gorilla about thirty years ago, and he brought to Europe some bones which were found to be different in their proportions from those of the chimpanzee already known, but nearer to that animal than to any other creature.

Dr. Savage's account.

Dr. Savage found it very difficult to get a view of the gorilla, alive, but he heard plenty of stories from the natives about his size and ferocity, his ability to combat the lion, his attacks on elephants, and his mastery of leopards. Evidently he was the forest enemy most dreaded by the hunters. His tree-climbing habits, his shuffling, scrambling gait on the ground, his tree-nests or sleeping quarters, were fully described to this investigator. The native name was written down as Ngina.

Accounts of natives.

Du Chaillu was the investigator who started in 1855, determined to see and capture gorillas, and whose artistic writings have invested the subject with romantic associations. We cannot do better than quote his words about his first victim: "Nearly six feet high, with immense body, huge chest, and great muscular arms, with fiercely glaring, large, deep grey eyes, and a hellish expression of face, which seemed to me like some nightmare vision, there stood before us the king of the African forest. He was not afraid of us. He stood there and beat his breast with his huge fists till it resounded like an immense bass drum, which is their mode of offering defiance; sometimes giving vent to roar after roar. The roar of the gorilla is the most singular and awful noise heard in these African woods. It begins with a sharp bark like an angry dog, then glides into a deep bass roll, which literally and closely resembles the roll of distant thunder along the sky, for which I have sometimes been tempted to take it when I did not see the animal. His eyes began to flash fiercely, for we stood motionless on the defensive, and the crest of short hair which stands on his forehead began to twitch rapidly up and down, while his powerful fangs were shown as he again sent forth a tremendous roar. He advanced a few steps, then stopped to utter that hideous roar again; advanced again, and finally stopped when at the distance of about six yards from us, and then we fired and killed him. With a groan which had something terribly human in it, and yet was full of brutishness, he fell forwards on his face."

Du Chaillu's first gorilla.

BABOON.

Du Chaillu describes a view of gorillas eating plantains.

"In destroying a tree," says he, "they first grasped the base of the stem with one of their feet, and then with their powerful arms pulled it down. They then set upon the juicy fruit of the tree at the bases of the leaves, and devoured it with great voracity. While eating, they made a kind of chuckling noise expressive of contentment." The pith of sugar-canes, and pine-apples, are also among their favourite food. Gorillas are sometimes met with solitary or in pairs, but more frequently in groups of from five to ten.

Gorillas feeding on plantains.

The ferocity of the gorilla is a cardinal article of belief with Du Chaillu. He obtained a young one about three years old, and two feet six inches in height, whose fierce and untamable character he vividly describes. When recaptured after an attempted escape, he says, "I never saw so furious a beast in my life as he was. He darted at every one who came near, bit the bamboos of the house, glared at us with venomous and sullen eyes, and in every motion showed a temper thoroughly wicked and malicious. He always snarled at me, and only when *very* hungry would he take even his choicest food from my hands. Daily attentions from me for a fortnight did not bring me any further confidence from him than this."

Ferocity of gorilla.

The ferocity and man-hating character of the gorilla have been disbelieved by many, partly on account of the "sensational" writing of Du Chaillu, and we cannot say that the entire truth is by any means satisfactorily attained at present. A male gorilla only two years old was sent by ship to England, but did

Contrary accounts.

not arrive safely. He was given full liberty of roaming, which he enjoyed, but ultimately appears to have fallen unobserved into the sea, and been drowned. Besides such fruits as were carried for his food, he was allowed to eat, and relished, table-fragments. He was merely shy at first, and did not manifest any unpleasant disposition. Even a bull-terrier was admitted to his warm friendship, and they ate and played together. A very striking peculiarity was that this young one did not acquire the habit of climbing the rigging. Another young one brought to England has been described as entirely playful, inquisitively examining every stranger in minute detail, behaving very much like a child in many particulars. His diet was mixed, including both meal and fruit; he clapped his hands like a child, and pointed with his index finger.

A tame young gorilla.

One of Du Chaillu's hunters killed a female gorilla which had a tiny baby clinging to it. A touching scene ensued. The little creature "crawled over her body, smelt at it, and gave utterance, from time to time, to a plaintive cry—'Hoo, hoo, hoo!' I could get no milk for this poor little fellow, who could not eat, and consequently died on the third day after he was caught."

A baby gorilla.

Mr. Winwood Reade is an African traveller who impeaches the accuracy of Du Chaillu's stories, but he does not himself ever appear to have seen the gorilla in the wild state. However, he satisfied himself by inquiries from very many natives, including those who had killed gorillas. Some naturalists are persuaded that Europeans have not yet seen this animal in its true forest retreats, and that he starts off at the slightest noise. There are not many fierce or large animals in the close-set regions of western equatorial Africa inhabited by the gorilla. There are few elephants, leopards, hyænas, no rhinoceroses or giraffes. Yet snakes are sufficiently abundant, one might think, to terrify and destroy the gorilla; the large birds of prey perhaps would be scared by his size or captured by his strength.

Winwood Reade's testimony.

Jungle and forest.

Let us hear Mr. Reade's direct testimony: "His food is strictly vegetable. He moves along the ground on all-fours, sometimes he goes up into trees to feed on fruit, and at night he sleeps in a large tree. The gorilla does not beat its breast like a drum. It utters a kind of short sharp bark when enraged, and its ordinary cry is of a plaintive nature. With respect to its ferocity, the hunters have a proverb, 'Leave a ngina alone, and it will leave you alone.' When it is at bay, and wounded, it will attack man like the stag, the elephant, and other animals which are naturally timid. I have seen a man who was wounded by a gorilla; his wrist was crippled, and the marks of the teeth were visible. When I asked the people of Ngumbi whether a man had ever been killed by a gorilla, they said that their fathers had spoken of such a thing, but that nothing of the kind had happened within the memory of anybody living."

Habits according to Reade.

XXXII.

DECIMALS (*continued*).

To convert a Recurring Decimal into a Vulgar Fraction.

FOR instance, to convert ·15234̇ into a vulgar fraction. Let F denote the value of the vulgar fraction. Then F = ·15234̇ = ·1523423423̇4 . . . . *ad infinitum.*

Now, if we shift the decimal point two places to the right, we shall be doing what is equivalent to multiplying the decimal by 100.

We have, therefore, 15·234̇ = 100 × ·15234̇ = 100 × F.

Again, if we move the decimal point three places further still to the right, this would be equivalent to multiplying it again by 1000.

We have, therefore, 15234·234̇ = 100000 × F.

If we now subtract 15·234̇ from 15234·234̇, the difference must be equal to that between 100 F and 100000 F.

Now, 15234·234̇ − 15·234̇ = 15234 − 15 (since evidently the decimal parts are equal).

And 100000 F − 100 F = (100000 − 100) × F = 99900 F.

Thus we have 99900 F = 15234 − 15.

Now, if we divide each of these equal quantities by 99900, we have

$$F = \frac{15234-15}{99900} = \frac{15219}{99900}.$$

Thus we see that the equivalent vulgar fraction is got in the following way:—

The numerator is got by subtracting the finite part (15) from the figures to the end of the period (namely, 15234), both considered as integer numbers.

And the denominator is got by subtracting 1 followed by as many ciphers as there are figures in the finite part, from 1 followed by as many ciphers as there are figures in the finite part and period together; and this difference must give for denominator a number made up of as many 9's as there are figures in the period followed by as many ciphers as there are figures in the finite part.

The method we have employed in this particular example to find F is perfectly general, and applicable to all recurring decimals. We shall illustrate it by applying it to one more example. Convert the recurring decimal ·7213̇ into a vulgar fraction.

Let F = ·7213̇.

∴ 1000 F = 721·3̇, and 10000 F = 7213·3̇.

∴ (10000 − 1000) F = 7213 − 721 = 6492, or 9000 F = 6492.

∴ $F = \frac{6492}{9000}$.

We can now see the reason for the following Rule, to convert a given recurring decimal into its equivalent vulgar fraction:—

1. *For Numerator* take the difference between the number formed by the figures in the finite part and that formed by the figures to the end of the first period, both considered as integer numbers.

2. *For Denominator* write as many 9's as there are figures in the period followed by as many ciphers as there are figures in the finite part.

Thus, $\cdot 31\dot{7}9\dot{8}\dot{4} = \frac{3179384-31}{9999000} = \frac{3179353}{9999000}$

$\cdot 563\dot{2} = \frac{56332-563}{99000} = \frac{55769}{99000}$.

If the decimal is a *pure* circulating decimal, we have a particular case of the above, and the same rule is applicable. As there is no finite part, we have only to write for numerator the period as it stands, and for denominator as many 9's as there are figures in the period.

Thus, $\cdot 6\dot{3}\dot{9} = \frac{639}{999} = \frac{213}{333} = \frac{71}{111}$

$\cdot 5\dot{1} = \frac{51}{99}$

When the decimal to be converted has an integer part, it is best to convert the decimal part alone. The answer will then be a mixed number, which we can convert to an improper fraction if necessary.

Example.—7·2235.

Taking the decimal part alone,

$\cdot 2235 = \frac{2235-22}{9900} = \frac{2213}{9900}$.

Therefore $7\cdot 2235 = 7\frac{2213}{9900}$.

Similarly $55\cdot 37\dot{8} = 55\frac{378}{999} = 55\frac{126}{333} = 55\frac{42}{111}$.

Exercises.

Convert into their equivalent vulgar fractions the following decimals :—

1.	2.
(*a*) ·2$\dot{1}$	(*a*) ·7$\dot{6}\dot{2}$
(*b*) ·9	(*b*) 7·6$\dot{2}$
(*c*) ·2$\dot{9}$	(*c*) 76·$\dot{2}$
(*d*) ·$\dot{9}$	(*d*) ·3$\dot{7}\dot{0}$
(*e*) ·0$\dot{9}$	(*e*) 3·70
(*f*) ·0$\dot{9}$	(*f*) ·230$\dot{3}$
(*g*) ·$\dot{7}\dot{7}$	(*g*) 2·30$\dot{3}$
(*h*) ·7$\dot{7}$	(*h*) 23·0$\dot{3}$
(*k*) ·3$\dot{3}$	(*k*) 230·3
(*l*) ·33	(*l*) 152·0006

Answers.

1. (*a*) $\frac{7}{33}$; (*b*) $\frac{9}{10}$; (*c*) $\frac{2}{10}$; (*d*) 1; (*e*) $\frac{1}{10}$; (*f*) $\frac{1}{11}$; (*g*) $\frac{7}{9}$; (*h*) $\frac{7}{9}$; (*k*) $\frac{33}{100}$; (*l*) $\frac{1}{3}$.

2. (*a*) $\frac{151}{198}$; (*b*) $7\frac{62}{99}$; (*c*) $76\frac{2}{99}$; (*d*) $\frac{367}{990}$; (*e*) $3\frac{7}{10}$; (*f*) $\frac{7677}{33330}$; (*g*) $2\frac{10}{33}$; (*h*) $23\frac{1}{33}$; (*k*) $230\frac{1}{3}$; (*l*) $152\frac{2}{3333}$.

Addition of Recurring Decimals.

We may either reduce the recurring decimals to their equivalent vulgar fractions and then add the fractions by the rules for addition of fractions ; or, if we only require a result approximately true (*i.e.* true to a certain number of places) we need only write down the decimal to a few places beyond the required number, and then add as if they terminated there.

Thus, find the following: ·6 + 3·2$\dot{1}$ + 32·4$\dot{4}$.

If we convert these into their equivalent vulgar fractions we have

$$\frac{6}{9} + 3\frac{21}{99} + 32\frac{4}{9}$$

$$= \frac{66}{99} + 3\frac{21}{99} + 32\frac{44}{99} = 35 + \frac{66+21+44}{99} = 36\frac{32}{99}$$

$$= 36\cdot 3\dot{2}$$

If we only require a result approximately correct, we have

·666666	To get the answer correct to four places, we write each decimal at full as far as five or six places, and then add by the rule for addition of ordinary decimals.
3·212121	
32·444444	
36·323231	Then stopping at the fourth place, the approximate answer is 36·3232, which is the same, so far as it goes, as the answer found by the first and more correct method.

Subtraction of Recurring Decimals.

To subtract one number from another, one or both numbers being recurring decimals, we may proceed by either method as in addition.

Example. —Subtract ·96 from 3·5$\dot{8}$.

By first method we have

$3\cdot 5\dot{8} = 3\frac{53}{90}$; $\cdot 96 = \frac{96}{100}$.

$\therefore 3\frac{53}{90} - \frac{96}{100} = 3\frac{530}{900} - \frac{864}{900} = 2\frac{566}{900}$.

And if we reduce the fraction to a decimal we have

$$\begin{array}{r} 566 \\ \overline{900)5660(\cdot 628} \\ 5400 \\ \hline 2600 \\ 1800 \\ \hline 8000 \\ 7200 \\ \hline 800 \end{array}$$

Ans. ·62$\dot{8}$, the 8 recurring as the remainder which gives rise to it recurs.

Thus, by this method we find the difference between the given decimals is 2·62$\dot{8}$ exactly.

By the second method we proceed thus :—

3·5$\dot{8}$ = 3·588888 (approximately)

·96 = ·960000

$\therefore$ difference = 2·628888 (approximately).

Thus by the second method we get the same answer as by the first, and the work is much shorter.

In additions and subtractions of recurring decimals, it will generally be sufficiently accurate, and always shorter, to adopt the second of these two methods.

But in multiplications and divisions, if recurring decimals come in, it is generally best to convert them into vulgar fractions before multiplying or dividing.

Thus, Example 1.—Multiply ·$\dot{7}$ by ·25.

$\cdot\dot{7} \times \cdot 25 = \frac{7}{9} \times \frac{25}{100} = \frac{7}{9} \times \frac{1}{4} = \frac{7}{36}$;

and if we wish to get the answer in the form of a decimal we must convert $\frac{7}{36}$ into a decimal.

We find it = ·194.

Example 2.—Divide ·75 by 3·$\dot{2}$.

$\cdot 75 \div 3\cdot\dot{2} = \frac{75}{100} \div 3\frac{2}{9} = \frac{3}{4} \div \frac{29}{9} = \frac{3}{4} \times \frac{9}{29} = \frac{27}{116}$

$$\begin{array}{r} 116)27\cdot 0(\cdot 2327 \\ 232 \\ \hline 380 \\ 348 \\ \hline 320 \\ 232 \\ \hline 880 \\ 812 \\ \hline 68 \end{array}$$

Ans. ·233 (approximately).

I. Find the values (correct to four places of decimals) of the following :—

(*a*) 1·32 + 17·19$\dot{1}$ + 108·00$\dot{1}$ + ·90$\dot{0}$

(*b*) 3·0$\dot{1}\dot{2}$ + ·11$\dot{3}$ + ·0$\dot{1}$ + ·7$\dot{3}\dot{4}$ + 115 + ·06$\dot{5}$ + ·00$\dot{2}$ + ·000$\dot{1}$.

II. (*a*) ·0865 − ·0234
(*b*) 15·137 − 13·215
(*c*) 100·001 − ·9.

III. (*a*) 37·23 × ·13
(*b*) 3·863 × ·297
(*c*) 3·973 × 4
(*d*) 74·0367 × 4·75

IV. (*a*) 31·791 ÷ 8.
(*b*) 2·297 ÷ 7·72
(*c*) ·084 ÷ ·036
(*d*) 9·928 ÷ ·26

Answers.

I. (*a*) 127·4163; (*b*) 118·9379.
II. (*a*) ·063; (*b*) 1·9226; (*c*) 99·001112.
III. (*a*) 4·964; (*b*) 1·14864; (*c*) 15·895; (*d*) 352·0856.
IV. (*a*) 3·973; (*b*) ·297; (*c*) ·1050; (*d*) 37·23.

To find the value of any decimal fraction of a given quantity.

As in vulgar fractions, multiply the given decimal by the number of units of the next lower denomination; the integral part (if there be any) will be so many units of that lower denomination, and the decimal part may be further reduced to the next lower denomination by a similar process; and so on.

Example 1.—Find the value of ·23 of £1.

·23
20
4·60 shillings
12
7·20 pence. Ans. 4*s.* 7·2*d.* or 4*s.* 7⅕*d.*

Example 2.—How much is ·3 of a cwt.?

·3
4
1·2 qr.
28
5·6 lb.
16
9·6 oz. Ans. 1 qr. 5 lb. 9·6 oz.

If the given decimal part is a circulating decimal, it is best to reduce it to a vulgar fraction.

It is sometimes necessary to reduce one quantity to the decimal of another given quantity. This can be done either by expressing the one as a *fraction* of the other, and then converting the fraction into a decimal, or by beginning with the term of lowest denomination in the first given quantity, expressing it as a fraction of the next higher denomination, and converting this fraction into a decimal; then, by a similar process, reducing this next higher denomination (including, of course, the decimal just found) to a decimal of the next higher; and so on.

Example.—Reduce 9¾*d.* to the decimal of £1.

¾)300
·75 ∴ 9¾*d.* = 9·75*d.*

$9{\cdot}75d. = \frac{9{\cdot}75}{12}$ shillings

12)9·75
·8125 ∴ 9¾*d.* = ·8125 shillings

$\cdot 8125 \text{ shillings} = £\frac{\cdot 8125}{20}$

20)·8125
·040625 £ Ans. ·040625 of £1.

The student can make examples of these rules by taking the examples given in Reduction of Vulgar Fractions, and converting the given fractions into decimals.

XXXI.

Mercury.

This planet, from its proximity to the sun, is only occasionally well placed for observation, so that the amount of information as to its appearance and physical condition possessed by astronomers is very meagre. It is a spherical planet 3000 miles in diameter, with a mass of about 1 ÷ 5,000,000 of that of the sun, so that in density it is about equal to the earth. It is surrounded by an atmosphere of considerable density and thickness, so that it is probable that astronomers never see the real surface of the planet, but only the upper cloud-layers. When carefully scrutinised by large telescopes, Mercury appears like a golden white disc, which takes all the phases of the moon, varying in appearance from a minute little disc 5″ in diameter, to a bright quadrant 7·5″ in diameter when near its greatest elongation from the sun, and thence to a brilliant little crescent nearly 12″ in diameter when approaching inferior conjunction. The real diameter of Mercury, when seen at the same distance as the sun from the earth, appears to be 6·76″, but when seen in a telescope it looks larger owing to the fringe of fictitious light due to irradiation. At times astronomers have observed faint grey spots and streaks on the planet, and from these observations it has been supposed that Mercury rotates on an axis inclined 70° to its orbit once in 24 h. 0 m. 53 s., but very great uncertainty attaches to these results. One of the most interesting phenomena presented by Mercury is its transit across the solar disc. These are not uncommon. The next occurrences are May 9th, 1891, and November 10th, 1894, both of which will be visible in England; the last one was November 7th, 1881, but was not visible in England. The planet appears like a round black spot, about 10″ in diameter, and surrounded by a faint ring of light, which at ingress and egress is visible as a bright ring of light surrounding the portion off the sun. Some astronomers have during the transit seen one or more bright spots near the centre of the planet, probably due to some purely optical effects of contrast.

Size and appearance.

Transits of Mercury.

Venus.

This beautiful planet is at times one of the finest objects in the heavens, shining so brilliantly as to dwarf even the great lustre of the giant Jupiter, and casting a distinct shadow on a moonless night. It is readily visible at such times in broad daylight, appearing as a tiny white speck on the deep blue noonday sky.

Venus, of all the planets in the solar system, is the one which most nearly approaches the earth in character, there being indeed but one

feature of any importance wherein Venus and the earth differ, and that is in the possession of a satellite: Venus has no moon. In all other respects the two planets much resemble each other.

Physical condition.

The diameter of Venus is 7900 miles, which is almost exactly that of the earth; its mass is 1 ÷ 400,000, which is about five-sixths of that of the earth, so its mean density is slightly less. From a number of observations of grey spots on the planet it has been calculated that Venus rotates on an axis inclined at 41° to its orbit once in 23 h. 21 m. 22 s., but, as in the case of Mercury, these determinations are very uncertain. In the telescope Venus varies in appearance from a tiny yellowish disc only 10″ in diameter, when beyond the sun in superior conjunction, to a brilliant silvery-white crescent 67″ in diameter when between the earth and sun in inferior conjunction; it appearing like a yellowish-white brilliant quadrant 20″ in diameter when near its greatest elongation. The true value of the diameter of Venus, when at the same distance as the sun from the earth, is 17·55″, but in the telescope, from its great brightness, it is so enlarged by irradiation as to appear from 1½″ to 2″ greater.

FIG. 80.

Venus is surrounded by a considerable atmosphere, which manifests its appearance during the transits of the planet across the sun by surrounding its disc with a narrow ring of brilliant silvery light, this ring being most noticeable at ingress and egress; but whenever the planet approaches very closely to the sun during inferior conjunction, the atmosphere manifests its presence by refracting the solar rays until the planet appears surrounded by a complete circle of light. From the observations made under these conditions by Madler and Lyman, it would appear that the amount of this refraction shows the density of the atmosphere of Venus to be nearly twice the density of the terrestrial atmosphere. Probably, therefore, what is seen when Venus is examined in a telescope is merely the upper cloud-bearing strata of its atmosphere. This view is in accord with the results of observation, for it is rarely that anything can be seen on the disc of Venus but a uniform yellowish-white surface. Occasionally very faint cloud-like grey markings have been detected, but they are very faint and their very existence uncertain. Traces of the effect of this atmosphere can be seen in the manner in which the border between the illuminated and unilluminated portions of the planet fade one into another, and also in the manner in which the cusps of the planet are prolonged. From observations with the spectroscope, Tacchini considers that this atmosphere contains traces of aqueous vapour.

Markings.

Judging from analogy, it is probable that the constitution of Venus is very similar to that of the earth, only its greater proximity to the sun and denser atmosphere combine to keep its skies perpetually covered with cloud, and so prevent our ever obtaining a view of the real surface of the planet, unless the faint grey spots be glimpses as if through a mist at the surface beneath. Were it not for this, Venus would be of all the planets the one best situated for study by us.

The transits of Venus across the sun are very rare phenomena, only two occurring every 130 years. The first transit was observed by the Rev. Jeremiah Horrocks, on 24th Nov. 1639.

Transits.

Venus appears like a very considerable dark round spot, some 64″ in diameter, and surrounded by a ring of light due to the presence of its atmosphere. Several observers have noted a bright spot on its centre, due probably to the same optical cause as the spot or spots seen on Mercury under similar conditions.

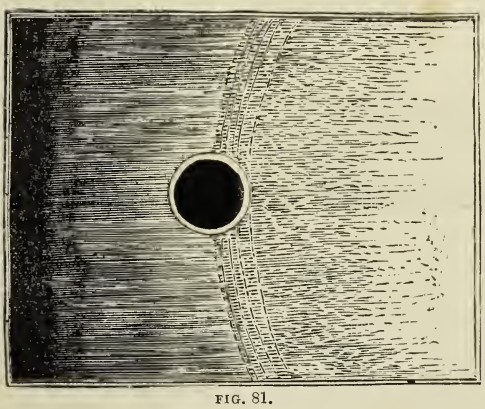


FIG. 81.

Years ago a considerable number of observers saw at different times an object which they believed to be a satellite to Venus, some of these observers being astronomers of considerable experience. Yet, though often searched for during the present century, this pseudo-satellite has never been seen. That Venus has no such satellite is now absolutely certain; what body was it which was seen by the early observers? or was it merely an optical illusion, due to some improper reflection of light from the eyepiece, or perhaps the side of the telescope—a *ghost*, as it is called? The latter is not an uncommon phenomenon; but some of the earlier observers seem to have taken great precaution to make sure it was not due to this cause. If not, what was the body?—one of the intra-mercurial planets? Not impossible: it may have been one of these: we cannot tell.

The Earth.

This member of the solar system scarcely comes within our scope, except in so far as certain astronomical constants; its size, history, and physical conditions coming within the domain of geography and geology rather than astronomy. There are certain astronomical constants, however, which must now be noted.

The earth is an oblate spheroid, with an equatorial diameter of 7926·6 miles, and a polar diameter of 7899·6 miles, corresponding to an ellipticity of $1 \div 292{\cdot}96$. There is, indeed, some reason for supposing the earth to be ellipsoidal in form, but our knowledge on this point is at present most uncertain. The mass of the earth is about $1 \div 327{\cdot}000$ of that of the sun, and the mean density about $5\frac{1}{2}$ times the density of water. The earth rotates on its axis once in twenty-four hours, and the axis is inclined to the terrestrial orbit by an angle of $66\frac{1}{2}°$; the obliquity of the ecliptic, or angle between the ecliptic and equator, being on January 1st, 1850, equal to 23° 27′ 31·83″ (Leverrier). It is slowly changing—decreasing every year by 0·47″. This decrease will not be perpetual, however, as the obliquity of the ecliptic only varies between the limits 21°58′36″ and 24° 35′ 58″. The equinox, or point where the ecliptic and equator cut one another, is slowly receding—the amount of this recession, or the precession of the equinoxes, as it is called, being 50·236″ per annum in the year 1850, it very slightly altering in the course of centuries. From this cause the apparent longitude of all the stars and other heavenly bodies increases by this amount every year. The best values for the two other similar astronomical constants are 9·236″ for the *Nutation*, and 20·445″ for *Aberration*.

Astronomical constants.

XXXIII.

SYNTAX.

Introductory Lesson.

Up to this time we have been considering words singly and by themselves, as separate parts of speech, either declinable or undeclinable, and declining them, whenever declinable—that is, going through their various cases and numbers, as nouns, pronouns, adjectives, and going through their various tenses and moods and numbers, as verbs.

But now we come to deal with *words in connection with each other* in a sentence; and it is this distinct and special relation of words to each other which we call Syntax, from a Greek word *Syntaxis*, which means *marshalling in order*—a military term first used of putting soldiers in order that they may move together and co-operate in all their duties. A single soldier, you know, is of no use to carry on a war: for this purpose we want an army composed of a large number of individual soldiers, commanded by one commander, animated with one spirit, and moving in obedience to certain regulations imposed on them. Now, a sentence you must look at as a little army, composed of a certain number of individual or single words, joined together and related to each other for a common purpose, or animated with a common sentiment, and acting in obedience to certain regulations and rules; and these rules, remember, we call the rules of syntax.

The Sentence.

The elementary parts of a sentence are two—the *Subject* and the *Predicate*.

The Subject is that whereof anything is said (either in affirmation or denial)—as CÆSAR *vincit*, *Cæsar* conquers, where Cæsar is the subject, because Cæsar is that of which *vincit* is said.

The Predicate is that which is said of the subject—as *Cæsar* VINCIT, Cæsar *conquers*, where *vincit* is the predicate, because it is said of the subject Cæsar.

Sentences are either Simple or Compound.

A *Simple sentence* expresses a single thought, and contains one finite verb—as *avis canit*, the bird sings.

A *Compound sentence* consists of two or more simple sentences combined into one sentence—as *Psittacus, nisi hominem imitatur, non loquitur*, the parrot does not speak, unless it imitates man.

Now, in this compound sentence, observe that *Psittacus non loquitur* would have been *by itself* a simple sentence, but it becomes a compound by the combination with itself of the subordinate clause, *nisi hominem imitatur*.

Every simple sentence takes one of three forms:—

I. Declaratory, which makes a *simple statement*—as *hic vir adest*, this man is present.

II. Petitionary, which makes a *simple request*—as *hic vir adsit*, let the man be present.

III. Interrogative, which asks a simple question—as, *nonne hic vir adest?* is not this man present?

The *Subject* of a sentence must be either a substantive or some word or words equivalent to a substantive in *sense*.

1. *India mittit ebur*, India sends ivory. Here the single word *India* is the subject of the sentence.

2. *Ille regit*, he rules. Here *ille*, a pronoun, is the equivalent of a noun, and so the subject of the sentence.

The subject of the sentence may be accordingly either—

(1) A substantive.

(2) A substantive pronoun—as in *ille regit*.

(3) An adjective or adjectival word used substantively—as in *verum est bonum*, what is true is good, where *verum* is an adjective used substantively.

(4) An adverb used substantively—as in

Parùm sapientiæ est, there is too little of wisdom, where *parùm*, the adverb, is used substantively, and as the subject.

(5) A verb-noun infinitive—as in *Ridere est gratum*, to laugh (*i.e.* laughing) is pleasant, where *ridere* is a verb-noun infinitive.

(6) A quotation or phrase—as in "*Ad arma*" *clamatur*, "to arms" is the cry, where *ad arma* is the quotation, and used as the subject of the sentence.

(7) A substantival clause—as in *Quid sit verum quæritur*, what is the nature of truth is made a question, or the subject of inquiry.

When pronoun nominatives are omitted, the personal ending of the verb indicates the subject, and the verb will sometimes contain the whole sentence—as in Cæsar's short, simple, and striking despatch, telling of his former victory in these words, each of which is an abbreviated sentence—*Veni*, I came; *vidi*, I saw; *vici*, I conquered. Here in each case the subject of the sentence is *ego*, the pronoun doing duty for the noun, and this is shown by the ending in *i*, for the perfect of *venio*, first person singular, you will remember, ends in *i*. Accordingly the verb in each of these cases combines both subject and predicate.

The *Predicate* of a sentence may be either a verb, an adjective, or another substantive, or an adverb.

I. A verb—as in *Omnia jam fient*, all things will now come to pass. Here *fient*, the verb, is the predicate.

II. An adjective—as in *Catilina multo hominum nequissimus*, Catilina was by far the most abandoned of men. Here *nequissimus*, the adjective, is the predicate.

III. Another substantive—as in *Hoc tempus est ver*, the season is spring. Here *ver*, the substantive, is the predicate.

IV. An adverb—as in *Hoc benè est*, this is well. Here *benè*, the adverb, is the predicate.

The simple sentence, both in its subject and in its predicate, is capable of considerable expansion by the addition of words or phrases, as adjuncts to the subject or adjuncts to the predicate; and this, observe, while the sentence loses nothing of its simple character as a simple sentence in opposition to a compound sentence. The subject of the sentence is sometimes enlarged by the addition of another substantive descriptive of it, and then the latter substantive is said to be in *apposition* with the former, and is put, remember, in the same case, generally in the same number, and if possible in the same gender—as in *Cicero, consul, Romam servavit*, Cicero the consul saved Rome. Here *consul*, the second substantive, is in apposition with Cicero, the subject of the sentence, and placed in the same number, case, and gender with it. This is enlargement of the subject by apposition—*i.e.* by *placing one* (word) *close to another*—as *appositio* means, from *positio*, placing, *ad*, close to.

Observe (1) this rule in *apposition:* that where substantives possess a double form—as *magister*, master (masc.), *magistra*, mistress (fem.), *minister*, servant (masc.), *ministrix*, servant (fem.), *inventor*, inventor (masc.), *inventrix* (fem.), inventress—the masculine form is always to be used in apposition with the masculine noun to which it is in apposition, and the feminine with the feminine: as in *Scelerum inventor Ulysses*, Ulysses (masc.) the inventor of crimes; *Oleæ Minerva* (fem.) *inventrix*, Minerva the inventress of the olive.

(2) When the substantive in apposition is not of the same gender or number as that to which it refers, the predicate usually follows the gender and number of the original subject—as in *Tullĭola, deliciolæ nostræ, munuseulum tuum flagitat*, Little Tullia, our little darling, clamours for your little gift. Here the subject of the sentence, *Tulliola*, is *singular*, but the substantive in apposition, *deliciolæ*, is *plural*, and the verb *flagitat* is made to agree with the *subject* noun, and not with the noun in apposition.

(3) When, however, the substantive in apposition is *civitas, urbs, oppidum*, or some such explanatory word, the predicate is then made to agree with the *word in apposition*, and not the subject of the sentence—as in *Volsinii, oppidum Tuscorum, concrĕmatum est fulmine*, Volsinii, a town of the Tuscans, was burnt up by lightning.

Adjectives and participles are sometimes used in apposition, and in this case they agree, as usual, with the substantives to which they are in apposition in gender, number, and case—as in *Artes ad victum necessariæ sunt innumerabiles*, the arts necessary to life are countless, where *necessariæ* is in apposition with *artes*, the subject, and agrees with it in gender, number, and case.

The predicate of the sentence may be enlarged by the extension of its object, or by the modification of the verb—as (1) in *Omnes boni amant pueros qui discent*, all good men love boys who will learn. Here *qui discent* is an enlargement of the predicate by the extension of *pueros*, the object of the verb transitive *amant*; and as (2) in *Omnes boni amant pueros bonos studiosissimo animo*, all good men love good boys with a most zealous mind. Here *studiosissimo animo* is the modification of the verb *amant*, and so an enlargement of the predicate.

Questions for Self-Examination.

What do you mean by syntax? How may you compare words to soldiers? What are the two elementary parts of a sentence? Define subject and predicate, and give examples. What is a simple sentence? What a compound sentence? What are the three forms of a simple sentence? Show in what way the predicate and subject may be enlarged, and give examples of each. What do you mean by apposition? Give examples of words in apposition. When adjectives and participles are in apposition, with what must they be made to agree? Give an example of the predicate of a sentence being enlarged by the extension of its object. Give an example of the predicate of a sentence being enlarged by the modification of the verb.

XXXII.

France under Richelieu and Mazarin.

The death of Henry IV. of France overthrew many plans for the advantage of the country and of Europe. The new king, Louis XIII., was only nine years old; and a decree of the Parliament of Paris gave the regency during his minority to the queen-mother, Mary of Medicis. The regent was a weak, yet ambitious woman, unable to comprehend or to follow out the system her husband had inaugurated, and anxious to secure her own safety by feeble concessions, and by close alliance with the court of Spain. The nobles, with the Prince de Condé at their head, were angry at the influence exercised over the queen by Eleonora Galigai, an Italian lady of honour, and by Concini, her husband, afterwards Marquis d'Ancre and Marshal of France. A mere courtier, without talent or merit, but immeasurably haughty and insolent, Concini contrived to enrich himself through his wife's influence and the queen's favour; and Mary weakly endeavoured to dispel the gathering gloom of discontent among the nobles by distributing with unreasoning and lavish profusion the sums the policy of Henry IV. had laid up for very different purposes. It was a period of reckless profusion among the rich, and of increased taxation and oppression over the poor. Sully, the great minister of Henry IV., chagrined and grieved to find his financial system overthrown, and the queen and the nobles working together to undermine the prosperity of the state, first remonstrated gravely, and then proudly took leave of the "Temple of the Goddess Moneta," carrying his wounded pride and just indignation into his retirement. In 1612 the king was declared to have attained his majority; but the system of misrule and extravagance continued as before.

The minority of Louis XIII.

Rosny, Duke de Sully.

LOUIS XIII.

The king, indeed, summoned the Estates-General in 1614, soon after he came of age; and this is the last occasion on which the national Parliament met, until the great revolutionary year 1789. Disunited and broken up into factions, they effected nothing; and with their dismissal another link was forged in the chain of French despotic government. Ten more years of misrule and oppression followed; the nobles encroached, the people suffered, and were overtaxed. Condé, who continued to be the enemy of the court, was imprisoned for three years in the Bastille. The feeble king, timid and sluggish as he was, at length listened to his favourite De Luynes, who remonstrated against the arrogant rule of the foreign favourites; and Louis consented to the murder of Concini. The haughty Maréchal d'Ancre was accordingly shot in the courtyard of the Louvre; the rabble of the city dragged his corpse in triumph through the streets. His wife, against whom the convenient accusation of the age, that of witchcraft, was alleged, boldly declared that the only witchcraft she had used towards the queen had been in the power a strong mind always possesses over a feeble one. She was condemned to death and executed. The queen-mother herself was banished to Blois; her influence was destroyed, and the king became virtually independent. But Louis had not the strength to stand alone. He leant on De Luynes, who, like Concini, was a mere court favourite, without genius or even honesty. The queen in her banishment, assisted by the Duke d'Epernon and other nobles, set up a rival court, and France was again distracted by faction and by a renewal of the Huguenot wars. The contest was unfavourable to the Protestants, who lost their strong cities, with the exception of Montauban and Rochelle. Just before the conclusion of the war De Luynes died. The king was already weary of him, and his power passed away with him, without leaving any permanent traces on the history of France. It was like the prophet's gourd, that grew up in a night and withered in a night.

The Estates-General dissolved.

Meanwhile a man of very different character had begun to make his power felt in the state—a man destined to stamp upon the page of French history the impress of despotism that was to be its characteristic for a century and a half,—a man whose word became far more powerful in France than that of the king himself,—Armand Jean du Plessis, bishop of

The Cardinal Richelieu.

Luçon, afterwards famous throughout the world as Cardinal Richelieu. At first an adherent of the queen's party, Richelieu had been removed from the public service when Mary of Medicis fled to Blois; he afterwards brought about a reconciliation between her and her son, and returned to Paris, where, after De Luynes' death, he not only rose to the head of affairs, but maintained himself for eighteen years in an almost dictatorial power, by the force of eminent talent backed by indomitable strength of will. The king disliked him, but yielded to him; the queen exhausted herself in feeble plots against his power, plots that resulted in her own confusion; the nobles leagued together against the overbearing churchman, and he outwitted them every one.

No king could have been more calculated than Louis XIII. to be influenced by a powerful minister; and never was weak king more favoured by fortune than was the feeble monarch to whom fate assigned the great cardinal, as if to relieve him of a burden too heavy for his weak shoulders to bear. Never was there a greater contrast than that between Louis XIII. and his parents. He had neither the energetic and popular qualities of his father, nor the love of pomp and magnificence that distinguished his mother. Weak in health, weak in intellect, he had the negative virtues of sobriety and frugality. A little hunting lodge at Versailles sufficed him for a palace; the royal stables, the royal table, the royal apartments were all meanly furnished. His speech was hesitating and stammering, his walk ungainly, his general behaviour indicative of timidity and distrust. Somewhat inconsistently, he took interest in hunting and in military pursuits. On the other hand, Richelieu might have been taken for a king far more easily than Louis. Ranke, the historian, gives a graphic picture of the great cardinal in 1629, thirteen years before his death,—a crowd of suitors and clients filling the rooms of his house,—the cardinal carried past in his litter, while one suitor presents a petition on his knees, another presses forward to kiss the hem of the cardinal's robe,—and how each man who receives a gracious glance retires "most rich in Timon's nod." For then already the chief direction of affairs was in his hands, and the cardinal's purple gave additional authority to the minister of state. Condé, the first prince of the blood, gave him the precedence. After that period his power increased greatly. In his park at Ruel he was the centre round which the whole system of government revolved. The king often came thither to consult him. When he visited the king he came surrounded by a guard larger and more imposing than that maintained by Louis. His palaces, stables, and retinue were far more complete and sumptuous than those of the king; and noblemen of the first rank were proud to take office in his household. He affected literary tastes, and had an especial liking for the drama, which was then in its infancy in France. His object in founding the French Academy was to purify the language from solecisms and provincialisms, and to gain for it the position among modern nations that the Greek and Roman tongues had occupied in the ancient world.

The Cardinal's Court.

MARIE DE MEDICIS.

The great objects of Richelieu were, first to extend the power and influence of France in relation to neighbouring states, and secondly, to increase the power of the king over the nation. To achieve the first object it was necessary, above all things, to work constantly and persistently against the might of Austria; to attain the second, it was requisite to crush the political sway alike of the Huguenots and the nobility. Thus, in the War of Succession of Mantua, he supported the claims of the Duke de Nevers against Austria; and in the Thirty Years' War repeatedly entered into alliance with the emperor's enemies in Germany. Then again, he strove perseveringly and successfully to destroy the almost independent power the Huguenots had established in the south, winding up a series of triumphs with the capture of the Huguenots' great bulwark, La Rochelle. A fourteen months' siege, during which the city was defended with unexampled heroism by the brave, good burgomaster, who only undertook the command under the condition that the first man should be slain who spoke of capitulation, rendered the name of Rochelle famous. In vain did the citizens resist until fifteen thousand had perished by hunger, and until not a hundred and fifty un-

The Huguenots and La Rochelle.

wounded soldiers remained in the place. In vain did England send an army under the imperious Buckingham to the relief of the beleaguered city. With La Rochelle fell the political power of the Huguenots; but Richelieu, a strict politician, but no fanatic, left them in enjoyment of religious freedom, by the ediet of Nîmes. The defeat of the Huguenots left the discontented nobles without support, and accordingly the most dangerous of them were attacked and defeated by the indomitable cardinal. At the head of the enemies of Richelieu stood Gaston, duke of Orleans, brother of the king, heir presumptive, and indeed for many years considered as heir apparent, of the kingdom. Gaston of Orleans was the chief hope of all the discontented spirits who longed for Richelieu's fall; and open war and secret conspiracies continually menaced the power, and even the life, of the great minister. But Richelieu forced Marie de Medicis, who supported her son Gaston, to retire from France and end her days in obscurity at Cologne; he drove Gaston himself from France, and the Duke of Montmorenci and the Marshal Marillac, the chief supporters of Gaston and the queen-mother, perished on the scaffold. The last and greatest triumph of Richelieu occurred when the cardinal, weak and exhausted by illness, had to be carried in a litter from place to place. It was in the detection and frustration of the celebrated conspiracy of Cinq Mars. This Cinq Mars was a young and ambitious nobleman in the king's serviee, who considered himself neglected by the cardinal; he accordingly laid a plot for his ruin, with the connivance of the queen, Anne of Austria, the dukes of Bouillon and Orleans, De Thou, the son of the great historian, and even of the feeble king himself. But Louis could not withstand Richelieu; a single interview with the powerful and determined cardinal, and the king was detached from the party of the conspirators. De Thou and Cinq Mars died on the scaffold at Lyons; the dukes only purchased pardon at the cost of great and humiliating saerifiees. A hard, and sometimes even a cruel man, Richelieu maintained his ascendency by the external strength and glory of France under his rule. Never had France possessed so strong and well disciplined an army,—never had the laws been more strictly administered, or the finanees brought into such order, as during the administration of that despotic minister of a feeble king.

Richelieu's enemies.

Conspiracy of Cinq Mars.

Death of Richelieu.

Louis XIII. survived his great subject only five months, dying on the 5th of May, 1643; a prinee of a feeble, colourless, eharacter, easily brought under the influenee of any man who had the art of making himself agreeable or formidable to him; incapable of greatness either in good or evil. He had disliked Richelieu even while he leaned upon him, and would have been glad to emancipate himself from the great minister's influence had he but seen the way to put down the cardinal first and to stand alone afterwards. But he stood passively by, "letting 'I dare not' wait upon 'I would,' like the poor cat in the adage," and was content to play the part of a "roi fainéant," while Richelieu, ruling with royal state in the Palais Royal, then called the "Palais Cardinal," triumphed successively over all who threatened his power, ruining the Huguenots, humiliating the house of Austria, banishing the queen, decimating the nobles, overawing the parliament, and superseding by his sole authority the acts and jurisdiction of the ordinary tribunals. Greater than Wolsey as a statesman, Richelieu infinitely surpassed the minister of Henry VIII. in power also; for Wolsey had to mask his ambitious designs, and above all things to please his haughty and imperious master, while Richelieu took hardly any trouble to conciliate the feeble spectre on the French throne.

Result of Richelieu's rule.

THE VIRTUE OF PATIENCE.

BY THOMAS DUNMAN.

FEW virtues are more to be commended or more useful than that of patience. However fortunate the lot of any may be, there are sure to arise many petty worries and anxieties against which the only available armour is calm and enduring patience.

The student in his endeavours to inform his mind and enlarge his mental faculties has especial need for the exercise of this virtue, and the want of it is a serious obstacle in his path. In the nature of things there can be no royal road to learning, and indeed if there were the value of knowledge would be very materially lessened, for it would no longer exercise upon the mind that sobering and chastening influence to which it owes its greatest value. The path of knowledge is rough and thorny, with many a slough of despond upon it, and many a lofty hill up which the learner must patiently toil; and all that the best teachers can do is to guide the student's unwary footsteps, and to help him to meet with a eheerful spirit the difficulties of the way. But, without doubt, the student who has most occasion for the exercise of patienee is he who is endeavouring to teach himself, and it is only by opposing a steady perseverance and an indomitable will to the many obstacles in his path, that such an one can attain success. Nevertheless, if the self-teaching student do but "possess his soul with patience," his success is perfectly sure, and the reward which it will bring proportionately enhanced.

In commencing a course of study, it is of the highest importance to carefully "count the eost," for if this be done at the outset, far less disappointment and loss of patience will result than is too often the case. However brilliant the natural gifts, patient plodding is essential to success, and when the difficulties to be surmounted seem almost insuperable, the spirit of

the student must rise to the occasion. In the present day the acquisition of a certain amount of knowledge is essential to even moderate uccess in life, and when the labour expended upon the study of any branch of knowledge seems unendurable, it is necessary to bear in mind the great importance of the object aimed at, and to press patiently onwards. What a world of meaning there is in that one word "education"! Not only does it express the possession of certain items of information, but it implies a well-trained mind, furnished with every intellectual weapon, and fully prepared to get the utmost out of life, and to quaff from a brimming beaker an ample draught of the truest pleasure. Surely this is an object for the attainment of which no expenditure of patient toil, however prolonged, can be considered too much; and yet how many miss the goal because they are too impatient to reach it!

For the student, and especially for the self-teaching student, the old maxim "Hasten slowly" is a golden one. Let every portion of a subject be thoroughly mastered before the succeeding one is even looked at, for it is want of patience in the study of the elementary parts of a subject which is most fatal to success. Just as a bad foundation is fatal to the stability of a building, no matter how elegant the superstructure, so an imperfect knowledge of the rudiments of a subject renders an acquirement of its higher branches an impossibility. In every subject a certain amount of drudgery must be done before the more interesting portions can be studied; and we would most earnestly advise our readers to exercise an unremitting patience in their earliest labours in any branch of study, as they can never thoroughly enjoy the beauties of a language, or an art, or a science, unless they have most thoroughly mastered its rudiments. Every one knows Dickens's humorous description of his attempts to learn shorthand; and how, after having with infinite pains succeeded in taking down a speech, he found himself utterly unable to decipher his notes. Humorous as this description is, it has an undercurrent of grim truth in it; and what is true of shorthand is true of every other branch of human knowledge: more than once must the student turn back to the rudiments of his subject before he can regard a knowledge of it as his own enduring possession.

Patience is a very valuable quality to the business man as well as to the student. However carefully his business may be conducted, and whatever precautions are taken against mishaps, circumstances will constantly crop up which are of a more or less irritating and annoying character. If these incidents be met with patience and good-humour, they produce but little harm, but the mischief is multiplied and the annoyance intensified where there is a lack of patience. It is well to bear this fact constantly in mind, as the exercise of a little patience under the petty worries and anxieties of business life will greatly reduce their power to inflict annoyance. A charitable consideration for the difficulties and disadvantages under which those with whom we come in contact labour, will greatly assist in the exercise of patience. If we could only know the trials and troubles of the irritable and ill-tempered amongst our acquaintances, we should feel much more disposed to bear with their infirmities and to deal patiently with their objectionable displays.

Patience is very necessary to those just entering upon a business career. The position of a junior in an office or warehouse is frequently a very unenviable one, and there is much to do which is unpleasant, especially at an age when our self-esteem is usually very high; but it is necessary to exercise patience if we wish to rise to a more enjoyable position. Patient good-temper goes a long way to conciliate even overbearing superiors, and will do much to shorten the period of probation.

One of the most important spheres for the exercise of patience is found in our dealings with our friends and relations. Unfortunately, human nature is far from perfect, and we meet but few individuals who are entirely free from objectionable peculiarities. Narrowness, prejudice, bigotry, bad temper, stupidity, and ill-nature are encountered at every turn, and they frequently cause the larger part of the trials and troubles of life. It is a rare and fortunate circumstance when an individual does not possess amongst his circle of friends one who in some respects "wants managing." There are so many uncertain and unreliable human beings in this world, so many persons who display what the Scotch call "thrawnness" (that is, awkwardness or contrariness), that it is only by the exercise of much long-suffering patience that we can escape constant annoyance. It is not only the duty of every one to bear patiently with the petty annoyances of life, but it is also the best policy to do so. There are few individuals who have not at some time in their life to endure illness, and under this affliction patience is a sovereign remedy. To an active person the enforced leisure attending an illness is extremely trying, and there is a tendency to murmur under the infliction. This, however, is foolish as well as wrong. However tedious the recovery from an illness may be, it is well to remember that impatience will not accelerate, but retard it, and that a return to active life before perfect convalescence is sure to work mischief, either in a speedy relapse, or in permanent injury to the constitution. When there is a temptation to display impatience and irritability during illness, it should be borne in mind that the sufferer is not the only person put to inconvenience. The position of nurse to a sick person is a very trying and unenviable one, and it often requires all the strength of a much-sacrificing affection to overcome the toil and unpleasantness of the self-imposed task.

Patience under adverse circumstances is a virtue very difficult to acquire, but all the more valuable for that reason. When fortune smiles, and everything is bright and promising, there is but little scope for the exercise of patience; but when the present and future are alike gloomy, the necessity for it is great indeed. Nevertheless, it is our duty as well as

our interest to be patient, however great our difficulties and discouragements. Remember that "it is a long lane which has no turning," and that the fickle goddess will, if we persevere and endure to the end, sooner or later favour us with her smile. Try to avoid the conclusion that your case is *particularly* unfortunate. Every lot has its dark side, every house its skeleton in the closet. Patient endurance of misfortune will alone half conquer it, while impatient murmuring does but increase the burden which we bear.

It must not, however, be forgotten that patience under misfortune or affliction does not by any means imply sinking under it. To give up hope, and to cease contending against ill-luck, is an impatient exhibition of cowardice. The patient man is he who uncomplainingly plods on in spite of misfortune, and endeavours to overcome the difficulties which surround his path. Cultivate the habit of looking at the bright side of everything, and while not forgetful of the necessity for exercising forethought, do not be over-anxious about the future.

In conclusion, we would impress upon all our readers the benefits which constantly flow from a patient and enduring disposition. Life abounds with temptations and trials and difficulties, and the most exasperating of these are by no means those of greatest magnitude. Petty worries and annoyances are severer trials to our patience than more serious anxieties. The littlenesses and weaknesses of friends, the petty meanness and spite of acquaintances, and the trifling delinquencies of children and servants, are more exasperating than really great troubles. "Insects have made the lion mad ere now," and these petty annoyances will be sure to cause an amount of friction quite incommensurate with their importance. But in cases like these, as in so many of the more serious worries and anxieties of life, the exercise of patience will largely diminish the liability to suffering.

BOTANY.

XXXII.

THE ROSACEÆ.

The Rosaceæ.

THE very name of the Rose-family is alluring, and very agreeably are one's anticipations fulfilled when the manifold contents of this most valuable and beautiful order come to be scrutinized. It may be regarded as essentially three, four, or even five-fold, having a counterpart, in the geography of countries, in the British Islands. These are, in a single word, Great Britain. Taken separately, the constituents are England, Scotland, Ireland, with the outlying islands which do not belong strictly to any one of the three. Just so is it with the Rosaceæ, which resolve into the Roseæ proper, the Pomiferæ or apple family, and the Drupiferæ or plum family, with, as accessory groups lying outside, the spiræa family, and the Lady's mantle family. Upon the principle already indicated, it is preferable to consider all these, in practice, as distinct and separate families. But there can be no doubt that they constitute an organic unity, the characters, up to a certain point, agreeing. Looking to the flowers alone, the grand essential is the insertion upon the calyx of a considerable number of stamens, surrounding a superior and simple ovary or a considerable number of such ovaries: the petals, when present, which is almost invariably the case, are also seated upon the calyx, and quite free, and the corolla, as a whole, is invariably regular.

The true Roseæ.

These have their best illustration in the rose *ipsissima*,—not in the grand "double" flower which is the pride of the "exhibition," but in the sweet and simple wild one of the hedgerow, the sweet-briar, and the little burnet-rose of the seaside sandhills. The flower of any one of these gives a perfect idea of the structure above described. So indeed does the flower of the common bramble, the strawberry, the avens of the hedgebank, the little golden tormentil, or any of the countless tribe of potentillas, including that lovely and universal wayside plant, the common silver-leaf, *Potentilla Anserina*. Placing these side by side, while struck by the charming identity as to fabric of blossom, it is impossible not to regard with profoundest surprise the extraordinary diversity of the fruit, and in a lower degree, that of the habit and general complexion of the respective species. As regards the latter, the roses and the brambles are mostly weak-stemmed scrambling shrubs, more abounding in prickles than is pleasant to the fingers; while in the strawberry and all the others we have innocuous little herbs, that sometimes scarcely lift themselves above the level of the ground. When the fruits are compared, the difference at first sight seems even greater. So grand, however, are the lessons in regard to *unity* supplied by the Rosaceæ, that were they devoid of all other invitations, these would be amply enough to make them engaging. The simplest presentation occurs in the potentillas, where we have a crowd of little dry one-seeded carpels dispersed upon the surface of a dry and convex receptacle. In their near relatives, the Dryas and the Sieversia, the carpels are similar, but have each of them a long and beautiful silky tail, exactly resembling that of the clematis among the Ranunculaceæ. Moving on to the strawberry, the carpels are, as before, dry and one-seeded, but now the receptacle becomes enormously distended with sweet juice, so that they are thrown individually far asunder, and look like yellow specks upon the surface. Changing next to the consideration of the blackberry and raspberry, here the conditions of the two parts, receptacle and ovaries, alter again. The receptacle is dry, as in the potentillas, but the ovaries become juicy, and the result is a mound of little fruits which in reality are plums or cherries in minia-

ture—in botanical language termed "drupels." Is it possible, it may be asked, to trace a resemblance between any of these and the "hip" of the rose? Nothing is more easy. The outer portion of the hip of the rose corresponds to the receptacle of the strawberry and the potentilla. It differs only in being urn-shaped and concave instead of convex, while the seeming "seeds" in the interior are in truth independent and superior carpels, in no degree different from those of the silver-leaf. The roses and brambles are the only ligneous representatives of the Roseæ proper. Agrimony, the Comarum of the pondside, the various species of Geum, so much esteemed in gardens, the Duchesnea, and many others, show the diversity which can be presented in the herbaceous mode of growth; and if but a few are like the strawberry in respect of excellent contribution to the table, they seldom fail in prettiness and cheerfulness of blossom and foliage. The great majority belong to temperate latitudes, and mainly to those of the northern hemisphere. None of the species are deleterious: a few are useful in medicine as astringents.

FIG. 180.—HELLEBORE.

The apple-bearing section of the Rosaceæ consists entirely of trees and shrubs; and these again, as regards birthplaces, are almost wholly natives of northern temperate latitudes. The grand distinction is found in the structure of the fruit, and in the fewness of the ovaries, which never exceed five. The apple itself is one of the most remarkable fruits in nature. While in bloom, the five carpels which constitute the "core" are superior, free and distinct. As the seeds progress towards ripeness, the enclosing calycine tube joins up to them: an immense quantity of cellular tissue is developed, and eventually we get the apple, with, on the summit, the withered relics of the calycine lobes and of the stamens. The pear and the quince are formed in a similar manner. To this inestimable little rosaceous group belong also the hawthorn, with its long train of fair cousins, so much esteemed in gardens and pleasure-grounds;—the mountain-ash, the service-tree, the white-beam, the medlar, the amelanchier, and the cotoneasters in their many kinds. No single group of trees is in the aggregate more pleasing perhaps than the one before us, the copious and sometimes fragrant bloom helping to make the spring and summer bright, none doing its part more admirably than

"The milk-white thorn that scents the evening gale,"

The Pomiferæ.

FIG. 181.—ROSE LYCHNIS.

while in the autumn we owe to them all the glory and sweetness summed up in the generosity of the orchard.

The Drupiferæ are so named because the fruit is fashioned in every instance on the type of the plum and cherry—examples, as above described, of "drupes." All the species are ligneous, and most of them attain the stature and substance of the plum-tree itself, though a few trail upon the ground. The leaves are invariably simple and undivided; the flowers are perfectly rosaceous, but have only one pistil; the petals are, without exception, white or pink. Most of these interesting trees belong, like the Pomiferæ, to northern temperate latitudes. Like the Pomiferæ, again, they mostly blossom in the spring or early summer. They correspond yet further, in being in very many cases invaluable to man as fruit-bearers. For in this beautiful little group, in addition to the plum and the cherry, we have the greengage, the peach, the nectarine, the apricot, and the almond. On the other hand, many of the species are noted for their secretion of amygdalin, the chemical base of that deadly poison, prussic or hydrocyanic acid. It is this which renders "laurel water" fatal, and which is perceived in the peculiar flavour of the kernels of all kinds of stone-fruit, the bitter almond in particular. The pulpy portion of the black cherry-like fruit of the common laurel is quite devoid of this poisonous matter; hence it may be eaten with safety, though care must be taken not to swallow the seeds, in which the amygdalin reappears. Among our native British wild-flowers, there are none more pleasing than the three of this family familiar as the wild cherry, the bird cherry, and the common blackthorn. The two former, it is true, are tall trees, and the last-named is a shrub; but they count with the wild-flowers in respect of the delightful ornaments they are to the country. The wild cherry presents in fair seasons quite a sheet of snowy bloom. The bird cherry, though the blossom, produced in racemes, is not quite so conspicuous, has the advantage in its honey-like fragrance. The blackthorn enlivens the hedgerows with its profusion of milk-white petals long before the leaves come out—the peculiarity intended to be expressed in the name "black," the "whitethorn," or May, having its foliage and flowers side by side. In pleasure-grounds the Drupiferæ are represented by the above-named

The Drupiferæ.

common laurel, the Portugal laurel, and the almond, suffused with pink while the branches, like those of the blackthorn, are still without leaves.

Little, indeed, is there of outward resemblance between the rose *ipsissima* and the Spiræas. The flowers are minute, and being usually produced in large panicles, nothing seems to the superficial observer more inconsistent than to place them near together. But, as we have seen before, botanical affinities are determined not by the kind of cluster in which the flowers may grow, or by their dimensions. In all essential particulars the little blossoms of these pretty spiræas agree perfectly with the rose in its single state; and although the fruit now changes to a follicle, that is a change no greater than has already been witnessed in connection with the strawberry and the apple. Most of the spiræas are shrubs; the remainder are herbaceous, the latter including that well-known and very attractive native plant, the meadow-sweet, or queen-of-the-meadows. The powerful odour of the large and plume-like panicles gives it quite a front place in the list of our choicest English wild-flowers. It is valuable also as supplying material for a very elegant and delicate substitute for plaister in case of slight cuts. Let a few panicles be gathered, and laid to dry in the shade, then rubbed to powder, and the lumps removed by sifting through muslin. The creamy-yellow dust so obtained, laid upon a little cut or similar wound, dries it up almost directly, and being astringent, soon binds the edges and heals the surface. In gardens there are many lovely shrubs of the same genus, many with pink flowers, but none worthy of compare with the meadow-sweet in point of odour. The leaves of the spiræas are either simple and undivided, or deeply and even doubly pinnatifid, and not infrequently have large and handsome stipules.

The Spiræas.

XXXI.

§ 200. Full conjugation: Active voice.
§ 201. Conjugation of Passive voice.

§ 200. FULL CONJUGATION OF ACTIVE VOICE.

INFINITIVE MOOD. To give.*

Verbal Noun and Present Participle, giving.
Passive Participle, given.

INDICATIVE MOOD.

Present Tenses.

	Singular.	*Plural.*
Indefinite.	I give	we give
	thou givest	you give
	he gives, giveth†	they give.
Continuous.	I am giving	we are giving
	thou art giving	you are giving
	he is giving	they are giving.
Perfect.	I have given	we have given
	thou hast given	you have given
	he has given	they have given.
Perf. contin.	*S.* I have been giving	
	thou hast been giving	
	he has been giving.	
	P. we have been giving	
	you have been giving	
	they have been giving.	

* *Give* is a strong verb; it is transitive, we therefore get it in both active and passive voice. See before, §§ 82, 84.
† Archaic form; also used in poetry. See § 186.

Past Tenses.

	Singular.	*Plural.*
Indefinite.	I gave	we gave
	thou gavest	you gave
	he gave	they gave.
Continuous.	I was giving	we were giving
	thou wast giving	you were giving
	he was giving	they were giving
Perfect.	I had given	we had given
	thou hadst given	you had given
	he had given	they had given.
Perf. contin.	*S.* I had been giving	
	thou hadst been giving	
	he had been giving.	
	P. we had been giving	
	you had been giving	
	they had been giving.	

Future Tenses.

	Singular.	*Plural.*
Indefinite.	I shall give*	we shall give
	thou shalt give	you shall give
	he shall give	they shall give
Contin.	*S.* I shall be giving	
	thou shalt be giving	
	he shall be giving.	
	P. we shall be giving	
	you shall be giving	
	they shall be giving.	
Perfect.	*S.* I shall have given	
	thou shalt have given	
	he shall have given.	
	P. we shall have given	
	you shall have given	
	they shall have given.	
Perf. contin.	*S.* I shall have been giving	
	thou shalt have been giving	
	he shall have been giving.	
	P. we shall have been giving	
	you shall have been giving	
	they shall have been giving.	

SUBJUNCTIVE MOOD.

Present Tenses.

	Singular.	*Plural.*
Indefinite.	I give	we give
	thou give	you give
	he give	they give.

* To avoid confusion, the future tenses are here conjugated with the auxiliary *shall* throughout; but the differing uses of *will* and *shall*, according to person, to express the future, must not be forgotten. See § 184.

	Singular.	Plural.
Continuous.	I be giving	we be giving
	thou be giving	you be giving
	he be giving	they be giving.
Perfect.	I have given	we have given
	thou have given	you have given
	he have given	they have given.
Perf. contin. S.	I have been giving	
	thou have been giving	
	he have been giving	
P.	we have been giving	
	you have been giving	
	they have been giving.	

Past Tenses.

	Singular.	Plural.
Indefinite.	I gave	we gave
	thou gave	you gave
	he gave	they gave.
Continuous.	I were giving	we were giving
	thou wert giving	you were giving
	he were giving	they were giving
Perfect.	I had given	we had given
	thou hadst given	you had given
	he had given	they had given.
Perf. contin. S.	I had been giving	
	thou hadst been giving	
	he had been giving.	
P.	we had been giving	
	you had been giving	
	they had been giving.	

IMPERATIVE MOOD.

S. give thou *P.* give ye.

§ 201. **CONJUGATION OF PASSIVE VOICE.***

INFINITIVE MOOD. To be given.

Verbal Noun and Present Part., being given.
Passive Porticiple, been given.

INDICATIVE MOOD.

Present Tenses.

Indefinite. I am given, etc.
Continuous. I am being given.
Perfect. I have been given.

Past Tenses.

Indefinite. I was given, etc.
Continuous. I was being given.
Perfect. I had been given.

Future Tenses.

Indefinite. I shall be given.
Continuous. I shall be being given.*
Perfect. I shall have been given.

SUBJUNCTIVE MOOD.

Present Tenses.

Indefinite. I be given.
Perfect. I have been given.

Past Tenses.

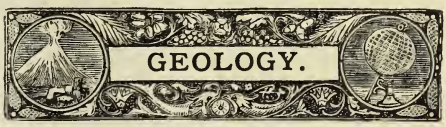
Indefinite. I were given.
Continuous. I were being given.*
Perfect. I had been given.

* The first person of each tense only is given; the student can fill up the rest for himself, having first referred to the conjugation of the verb *to be* in § 202.

IMPERATIVE MOOD.

S. be given. *P.* be given.

The use of the passive continuous tenses in the subjunctive (marked *) is not common, and is a clumsy form of expression. But we must recognize the tenses, as their possible use occurs in such phrases as the following: "*I shall be being tossed* on the ocean while you are in your bed" (indicative future); "if I *were being measured* for a dress, I should have it large enough" (subjunctive past).



XXVI.

Concluding Remarks.

In every department of science the student finds himself dealing with law. There is no such thing known as a "freak of nature." Effects follow causes in unvarying succession, and the appearance of disorder is due solely to our ignorance. If it were not so, "science," which is the orderly arrangement of accurate knowledge, could have no existence; but being so, every fresh advance renders further progress possible.

The universal existence of law.

The question therefore is naturally suggested whether any order in the succession of life on the globe has been discovered? Before this inquiry could be answered with any confidence, a large accumulation of facts was absolutely necessary—both as to the forms of animal life in the several stages of the world's history, and their relation to those of earlier and later date. In connection with these facts the results obtained in other departments of science have been combined, and it is now all but universally believed by scientific men that there has been a gradual development of life in the course of the earth's history from what are called the "lower" to the "higher" forms of vegetable and animal existence. In its crude shape this is not a new idea, but a very old one. It was not, however, generally accepted until Mr. Darwin presented it to the world in the form it assumed in his now celebrated "Origin of Species." That plants and animals are both like and unlike the stock from which they spring is not to be disputed: that is to say, no two animals or plants—notwithstanding that the family likeness may be preserved—are exactly and in all respects alike. The farmer knows this, and selects those animals from which to breed that show best the features he wishes to perpetuate. The most remarkable results are brought about by this method of "selection" amongst domesticated animals, as everybody knows who has given the subject the slightest attention; and the same practice adopted by florists and market gardeners leads to similar success.

Is there any order in the succession of life?

The theory of evolution.

"Few persons," says Mr. Wallace, "consider how largely and universally all animals are varying." We know, however, that in every generation, if we could examine all the individuals of any common species, we should find considerable differences, not only in size and colour, but in the form and proportions of all the organs of the body. In our domesticated animals we know this to be the case; and it is by means of the continual selection of such slight varieties to breed from that all our extremely different domestic breeds have been produced. Think of the difference in every limb, and every bone and muscle, and probably in every part, internal and external, of the whole body, between a greyhound and a bull-dog! Yet if we had the whole series of ancestors before us, we should probably find that in no one generation was there a greater difference than now occurs in the same breed, or sometimes even in the same litter."

Variation amongst animals of the same species.

Now, it is argued that a process of "natural selection" always in operation has modified, and continues to modify, the life of the earth. Everywhere in the vegetable and animal kingdoms there is a perpetual struggle for existence. A single thistle, if its increase were not checked, would fill the earth with its progeny in a very short time; and a pair of herrings would crowd the ocean with descendants in a few years, if their productiveness were unrestrained. A neglected garden would furnish a good illustration of this indisputable fact. If weeds are not kept down by constant care, they spread until they choke nearly everything else. Most of the flowers which the gardener prizes are not hardy; they are preserved from year to year only by assiduous attention: and when he leaves them they go down before their hardier brethren, the weeds—which are weeds only because they are so hardy as to grow where they are not wanted. The same principle extends through nature. That variation of plant life, or of animal life, which is in all respects best adapted to the circumstances in which it is placed, survives and is perpetuated.

Natural selection.

ANCIENT STONE IMPLEMENTS.

Suppose, to supply another easy illustration, that the entire population of Great Britain were to withdraw from these islands, leaving behind them the domestic and other animals. No one could safely undertake to predict all the changes that would follow, but some of them are readily anticipated. A large number of animals would die at once; deprived of the constant care of man, and compelled to seek their own food, they would inevitably perish. Some of our domestic animals would survive—a result due to their hardier nature, or greater intelligence, or both combined. The fortune of their descendants would depend upon the extent to which they improved upon the aptitude of their parents in adapting themselves to the new conditions; those which could do so most readily and completely would certainly fare best, enjoy the greatest health and vigour, and have the most numerous progeny inheriting their special characteristics. Meantime the animals now kept down by human agency—such as the fox, the deer, the rabbit, the hare, the weasel, the badger, the otter, the rat, and a large number of others which will occur to the reader's memory—would roam about unchecked by man, and multiplying, would soon become very numerous. A corresponding change would come over the vegetable world, and the land would become wooded again. The native plants, and those thoroughly acclimatised, would of course spread rapidly—those less fitted for the altered conditions dying out. After a time the struggle would become intensified: beast would war against beast and bird against bird, and then everything which could give an advantage, however slight, on the one side or on the other, would tell with great force,—fleetness of foot, cunning in concealment, or difference of colour (making it more or less protective), a scent varying in degree, a change of food, a thousand things insignificant to all appearance, would become important in the struggle for existence, and in the course of time very marked consequences, traceable from the lowest orders of life up to the highest, would be produced.

An illustration.

Man himself is a remarkable instance of the power of natural selection. There are very few who believe that the various races of mankind were specially created in different parts of the world. But assuming that all men sprang from one source, it is instructive to see how very marked in the progress of time the diversities of the human family have become. Like all other animals, man has been affected by his surroundings, and their total effect is seen in the peculiarities which separate the races.

Influence of natural selection on man.

So much is admitted on all sides. There is confessedly a process going on akin to that which is known to all animal breeders and cultivators who select the animals or plants with a special view to the characters they wish to perpetuate. That which is fittest for the purpose of the breeder or cultivator is preserved and used, and in the course of generations that character is intensified to a degree which would astonish any one who had not been prepared for such a result. In nature it is also "the fittest"—not necessarily that which we

Differences of opinion.

admire most, but that which is best adapted to its surroundings—that survives; and here too results are produced which are apt to create surprise. The question upon which men are not agreed is the extent to which the changes consequent upon that which we call "natural selection" are possible. The evolutionist believes that he has found in it the law by which the great Creator, working through the long ages of geological time, has been pleased to call into existence, first the lowlier forms of life, and then through successive stages the higher, until He has reached the crown of His creation—man. This is, as we have said, the general belief; and it is not contradicted by anything which we know of the ancient life of the globe. Others, however, believe that the limits of variation are soon reached, that different species were so created, and that they are separated by intervals which cannot be overpassed; while some, admitting the evolution of animals below man, regard the human race as a separate creation by the great Father.

Now, we are not only obliged to admit—it is a fact to be insisted upon and brought into prominence—that the geological "record" is manifestly and strikingly defective. It is only exceptionally that the remains of animals and plants have been preserved; the larger part have perished, leaving no recognisable trace behind. We can see that the same obliterating process is going on now, and need experience no surprise that in former ages it was equally effective. We may rather be thankful that so many records of past life have been preserved in the rocks, and that so much progress has been made in the method of deciphering them. It must be remembered, moreover, that the soft parts of animals are not preserved at all, and that of the hard parts it is seldom that the complete skeleton is met with. Most fossils (speaking, of course, of the higher forms) are fragmentary, and the entire animal has to be built up by a comparison of the remains of many different individuals—for which it is often necessary to wait a long time. Every year, however, is adding to our knowledge. Intermediate links in the great chain of life are coming to light in a sequence which appears to be only explicable upon the hypothesis of evolution.

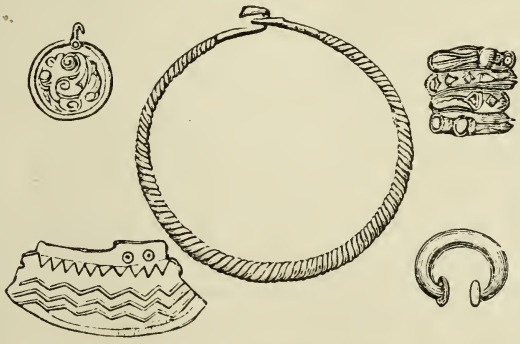
Supposing, however, that in evolution by "natural selection" we discover the key to the great problem; we have simply arrived at a better understanding of the process by which the divine power has chosen to work. There is nothing atheistic in the theory, and nothing which need in any way diminish our reverence for the Creator. So much it appears necessary to say since the advocates of evolution have had many hard things said of them—the saying of which has brought more disgrace upon those who have uttered them than the persons to whom they were applied.

Evolution not an atheistical theory.

We need not, however, pursue this subject further. One thing is abundantly evident—that through long ages a double process has been going on. On the one hand, animal life has been adapted to the changing features of the earth's surface, and that surface has been fitted for the successive developments of animal existence. There has been thus a double and reciprocal adjustment, of which the world as we know it to-day is the outcome: with more of its history written upon its surface and embodied in its structure than we have yet been able to make out. Some chapters are possibly gone beyond recall—obliterated and unintelligible for ever; but as new methods of research are devised, and new results reward studious and patient investigation, we hope to gain a fuller and more accurate acquaintance with what is now most obscure to us and apparently least likely ever to be understood.

Conclusion.

The small portion of space yet at our command will be devoted to lists of characteristic fossils.



ANCIENT ORNAMENTS.

XXX.

MANGANESE.

THIS metal is not generally known in the metallic form; in the condition of the black oxide, however, it is met with in the laboratory of every chemist. This compound, which is a dioxide, is found native; from it the metal may be prepared by heating with charcoal. At the same time, having a strong affinity for oxygen, it is difficult to reduce from its ore, and when reduced, must not be exposed to the atmosphere. It is a hard and brittle metal, slightly magnetic, and combining, like iron, with silicon and charcoal. Pure manganese is not used in the arts, but an alloy of this metal with iron is used in the manufacture of steel. Manganese imparts a purple colour to glass.

Black oxide of manganese.

Properties of manganese.

The principal oxides of this metal are the monoxide, MnO, a greenish powder formed by driving off the carbonic acid from the carbonate by heat. It forms with acids a series of pink-coloured salts, and rapidly absorbs oxygen from the atmosphere, passing into a higher state of oxidation. The sesquioxide, Mn_2O_3, exists in nature as the mineral called brannite. Its salts are somewhat unstable. It can be made to replace the sesquioxide of aluminum in alum. The dioxide is the common black ore or oxide of manganese. If an oxide of manganese is fused in the air with caustic potash, a green substance is formed whose solution will be found to contain a salt known as potassium manganate, H_2MnO_4. The solution, if left to stand, will be found to contain the salt known as permanganate, $KMnO_4$. The manganates and permanganates are used as disinfectants, from the fact of their giving up part of their oxygen in contact with organic matter. One of the best known disinfectants prepared from these salts is that called Condy's fluid.

Pink coloured salts of manganese.

An analogue of alum.

The permanganates.

Disinfecting agents.

The remaining metals of the iron group are nickel, chromium, uranium, and cobalt. The last of these perhaps most resembles iron in its physical attributes. It is a reddish-white, hard, and very tenacious metal, fusing only at a very high temperature, and, like iron, strongly magnetic. It is not found native, but is met with in combination with arsenic and sulphur in two distinct minerals. The cobalt salts are pink when hydrated and blue when anhydrous. The beautiful blue pigment known as cobalt is of course prepared from this metal, which is also used to impart a magnificent purple colour to glass. Nickel, like cobalt, is also met with native combined with arsenic in the mineral known in Germany as *Kupfernickel*. The metal itself is white, malleable, tenacious, and magnetic. It is used as an alloy in German silver and other compounds. The salts to which nickel gives rise are of an apple-green colour; they may also be distinguished from those of cobalt by their imparting a red colour to a bead of borax under the blowpipe, instead of the bright blue of the cobalt salts. Chromium appears to be the most infusible of all the metals. It cannot be melted at a temperature sufficient to fuse and even volatilize iron, platinum, and the more difficultly fusible of the metals. The term chromium, from the Greek word for colour, indicates its use in the arts as a pigment. Chromic oxide is employed for painting on porcelain, and giving a brilliant green. The green of the emerald is indeed thought to be due to this substance. The anhydrous chloride of this metal is obtained by sublimation in the form of beautiful crystals. The violet crystals of the anhydrous chloride of chromium may be obtained by passing a current of chlorine gas over a red-hot mixture of chromium sesquioxide and charcoal. Chromium sulphate, in combination with the sulphates of potassium and aluminum, forms a series of those salts known as alums, which have a deep purple tint, and are isomorphous, or have the same form with common alum. Many valuable pigments are prepared from the different chromic compounds; some being used in ordinary painting, while others are employed to impart various tints to glass. The rare metal uranium belongs to this class. The metal itself is of a steel-white colour, and does not oxidize in dry air at ordinary temperatures; when strongly heated it burns brilliantly, some of its compounds are used in photography, and its oxide imparts a brilliant yellow colour to glass.

Colours of the cobalt salts.

Cobalt a pigment.

Nickel.

Nickel salts.

Chromium an infusible metal.

Pigments of chrome.

Chrome alums.

Uranium.

THE TIN CLASS.

At the head of this class we of course place the metal from which it takes its name. This interesting and useful metal is by no means widely distributed; that is to say, its ores—for it is never met with native—are not found in many localities. The chief European source of tin is in the mines of Cornwall, whence the ancient world doubtless obtained the supplies of this metal used in the manufacture of bronze. We have every reason to believe that the Phœnicians, and after them the Romans, visited this country for tin. The term Cassiterides, "islands of tin," probably originated in a mistaken idea that Cornwall formed, with the Scilly Isles, a group of small islands. The principal ore of tin is tin dioxide, or tinstone, SnO_2. Tin is chemically distinguished by the Latin name of this metal, Stannum; hence its symbol is Sn. Tinstone is also met with in Malacca, in Borneo, and in Mexico. In the reduction of tin from its ore, the latter is first crushed, and then washed in water, so as to remove all the lighter portions of the rock in which it is imbedded. The tinstone is next placed in a reverberatory furnace, with anthracite coal, or charcoal, and a certain quantity of lime, when the oxide is reduced by a process similar to that described in connection with the manufacture of iron—the metal being set free and a silicate of lime or slag being left behind. The tin thus obtained is, however, far from pure, and has to undergo a second process of refining.

Tin.

Sparsely distributed.

Found in Cornwall.

The Cassiterides.

Reduction of tin.

The general appearance of metallic tin is too well known to need any special description. The metal, in the pure state, is but little used, but it is largely employed as an alloy in the manufacture of bronze, gun-metal, bell-metal, etc., and also for covering thin plates of iron, thus forming what is known as sheet tin or tin-plate. Tin is soft, malleable, and ductile, but possesses but little tenacity; it melts at the low temperature of 235°, and is but slightly

Tin as an alloy.

Tin-plate.

volatile. If strongly heated it takes fire, with the formation of stannic oxide, commonly known as "putty powder." Tin is attacked by both hydrochloric and nitric acids; but does not readily oxidize on exposure to air, wet or dry.

Fusing point of tin.

The two oxides of this metal are the monoxide, SnO, and the dioxide, SnO_2. The latter is met with native as tinstone, and can be prepared artificially in the form of a white powder. It imparts to glass a dead white colour, rendering it semi-opaque. Sodium stannide, formed by boiling tin dioxide with soda, is used in calico printing, as a mordant or means of fixing the colour of a dye; stannous chloride, or tin salts, as it is termed in commerce, is largely employed for the same purpose. The substance known as mosaic gold (aurum Musivum) is a sulphide of tin. The splendid purple colour known as purple of Cassius is formed when gold chloride is added to a dilute solution of tin chloride.

Oxides of tin.

Tin chloride.

Purple of Cassius.

The other metals of the tin class occur so rarely, and are so little used, as to call only for the briefest notice. Titanium is a metal known only in the form of a grey powder, and resembling tin in its general properties. It is distinguished by its power of uniting with nitrogen at a high temperature; of iridium and tantalum we know even less than we do of titanium.

Other metals of the tin class.

The rare metal tungsten forms a class with molybdenum. This metal is met with native combined with ferrous oxide in the mineral wolfram, and also combined with lime as scheelite. The addition of a small quantity of this metal to steel renders it hard and durable. The compound known as sodium tungstate possesses the valuable property of rendering light cotton or linen fabric uninflammable; being soluble in water, it can be added to the starch used to stiffen muslin and other light inflammable materials.

Uses of tungsten.

Sodium tungstate.

Antimony, bismuth, and vanadium, form another class. Antimony may be regarded as belonging to the class of bodies that form the links between the metallic and non-metallic elements. Like arsenic, it forms a gaseous compound with hydrogen, but in some respects exhibits attributes so decidedly metallic as to entitle it to a place among this class of elements. It is met with both native and in combination with other substances—from which compounds, however, it may easily be reduced. Antimony is a bright metal of a bluish-white colour, crystallizing in rhombohedra, isomorphous with arsenic. It is so brittle that it may be pounded to powder in a mortar. Antimony undergoes no change in air at ordinary temperatures, but oxidizes rapidly if exposed in a molten state. When heated sufficiently it takes fire, burning with a white flame and the formation of a trioxide. Antimony melts at 450°, and various useful alloys of this metal exist. Of these type metal or printers' metal—in which the letters used in printing are cast—is the most important. This consists of about 30 per cent. of antimony united to lead. Three oxides of antimony exist, being one more than is known in the arsenic series. This metal, in a finely powdered state, takes fire if thrown into chlorine gas, with the formation of its chlorides, of which there are two. The symbol of antimony is Sb, the chemical term by which it is distinguished being Stibium. SbH_3 will therefore represent antimoniuretted hydrogen, which will be recognised as an analogue of arseniuretted hydrogen. This gas is evolved when an antimony salt is brought into contact with zinc and dilute sulphuric acid. Like the corresponding arsenic compound, it burns with a blue flame, evolving white fumes of antimony trioxide. The compounds of antimony, like those of arsenic, are highly poisonous, and the means of detecting them is therefore a matter of great importance in connection with medical jurisprudence.

Antimony class.

Attributes of antimony.

Type metal.

Antimoniuretted hydrogen.

Antimony compounds poisonous.

Bismuth is a metal of a pinkish-white colour, melting at 264°. If strongly heated it burns with a blue flame and the formation of an oxide. Bismuth likewise takes fire in chlorine. Its compounds are used in medicine and as pigments. Bismuth is chiefly procured in Saxony from the mines of Schneeberg, where it occurs mixed with cobalt speiss in the proportion of about 7 per cent. The metal vanadium, the last of the series, is too rare to call for special notice.

Bismuth.

XXXIII.

Numeral Adjectives (*continued*).

We have now to speak of the Ordinal numbers.

They are formed by adding te or ſte (after a number ending in ig) to the cardinal, the te being equivalent to the English *th:* four, fourth, vier, vierte. They are all declined according to the forms of adjectives (see these) —ein vierter, eine vierte, ein viertes, like the adjective with indefinite article—der vierte, die vierte, das vierte, like the adjective with definite article—der gute, die gute, das gute, etc. As in the cardinal numbers, the unit precedes the ten: thus, the three-and-fiftieth, der drei und fünfzigſte, not the fifty-
dare dry unt fuennf'-tsich-ste
third. Repetition of times (multiplication) is expressed by the word Mal, equivalent to the
mahl
French word *fois*—as fünf-mal, five times;
fuennf'-mahl
hundert-mal, a hundred times: Es iſt das
hunn'-dert-mahl es ist dass
drei und dreißigſte Mal, it is the thirty-
dry unt dryss'-ich-ste mal

third time. The multiplication table is called das Ein=mal=eins, the one-time-one.
ine mahl eince

der erſte, the first
dare airr'-ste

der zweite, the second
dare tsvy'-te

der dritte, the third
dare drit'-te

der vierte, the fourth
dare fearr'-te

der fünfte, the fifth
dare fuennf'-te

der ſechſte, the sixth
dare zex'-ste

der ſiebente, the seventh
dare zee'-ben-te

der achte, the eighth
dare ach'-te

der neunte, the ninth
dare noin'-te

der zehnte, the tenth
dare tsayn'-te

der elfte, the eleventh
dare elf'-te

der zwölfte, the twelfth
dare tsvoelf'-te

der dreizehnte, the thirteenth
dare dry'-tsayn-te

der vierzehnte, the fourteenth
dare fearr'-tsayn-te

der fünfzehnte, the fifteenth
dare fuennf'-tsayn-te

der ſechzehnte, the sixteenth
dare zech'-tsayn-te

der ſiebenzehnte or ſiebzehnte, the seventeenth
dare zee'-ben-tsayn-te zeeb'-tsaynte

der achtzehnte, the eighteenth
dare acht'-tsayn-te

der neunzehnte, the nineteenth
dare noin'-tsayn-te

der zwanzigſte
dare tsvan'-tsich-ste

der ein und zwanzigſte
dare ine' unt tsvan'-tsig-ste

der dreißigſte
dare dryss'-ich-ste

der vierzigſte
dare fearr'-tsich-ste

der fünfzigſte
dare fuennf'-tsich-ste

der ſechzigſte
dare zech'-tsich-ste

der ſiebenzigſte or ſiebzigſte
dare zee'-ben-tsich-ste zeeb'-tsich-ste

der achtzigſte
dare ach'-tsich-ste

der neunzigſte
dare noin'-tsich-ste

der hunderſte
dare hunn'-der-ste

der hundert und erſte
dare hunn'-dert unt airr'-ste

der hundert und zweite, etc.
dare hunn'-dert unt tsvy'-te

der zwei hundertſte
dare tsvy' hunn'-dert-ste

der drei hundertſte
dare dry' hunn'-dert-ste

der tauſendſte
dare tow'-sent-ste

Study on the Cardinal and Ordinal Numbers.

Die Stadt Brighton iſt fünfzig engliſche
dee statt brigh'-ton ist fuennf'-tsich en'-gli-she
Meilen von London. In dem Jahre vier=
my'-len fon lonn'-don in dame yah'-re fearr'-
zehn hundert zwei und neunzig wurden
tsayn hunn'-dert tsvi unt noine'-tsich voor'-den
die Weſt=Indiſchen Inſeln von Chriſtoph
dee vest in'-di-shen in'-zeln fon chris'-tof
Columbus entdeckt. Napoleon gewann die
co-lum'-bus ent-dekt' na-po'-le-on gevann dee
großen Schlachten bei Auſterlitz und bei
gross'-en shlach'-ten by ows'-ter-litz unt by
Jena. Sie wurden in den Jahren acht=
yai'-nah zee voor'-den in dane yah'-ren acht'-
zehn hundert und fünf, und achtzehn
tsayn hund'-ert unt fuennf unt acht'-tsayn
hundert und ſechs geliefert. „Zwanzig
hun'-dert unt zex ge-lee'-fert tsvan'-tsich
Jahre," ſagt Schiller's Don Carlos, „und
yah'-re zaacht schiller's don carr'-lós unt
nichts für die Unſterblichkeit gethan."
nichts fuer dee un-stair'-blich-kite ge-tahn'
Am zweiten April im Jahre ſiebzehn
am tsvy'-ten ah-pril' im yah'-re zeeb-tsaynp
hundert ein und neunzig ſtarb nach
hund'-ert ine unt noine'-tsich starp nach
kurzer Krankheit der große Redner
koor'-tser krank'-hite dare gross'-e rayd'-ner
Mirabeau. Richard der Zweite König
mee'-rah-bo rich'-art dare tsvy'-te koe'-nich
von England war der Enkel Eduards
fon enn'-glant vahr dare en'-kel ay'-dou-arts
des Dritten. Nachdem der unglückliche
dess drit'-ten nach-dame dare un-gluck'-li-che
Kaiſer Peter der Dritte im Kerker
ky'-zer pay'-terr dare drit'-te im kayrr'-kerr
umgebracht worden war, beſtieg ſeine
um'-ge-bracht vorr'-den vahr be-steech' zy'-ne
Wittwe Katharina die Zweite den Ruſſi=
vitt'-ve kat-a-ree'-nah dee tsvy'-te dane rus'-si-
ſchen Thron. Ihre Regierung dauerte bis
shen trone ee'-re ray-gee'-rung dow'-er-te bis
in das Jahr ſiebzehn hundert und ſechs
in dass yahr zeeb'-tsayn hun'-dert unt zex'
und neunzig. „Schier dreißig Jahre biſt
unt noine'-tsich sheerr dryss'-ich yah'-re bist
du alt," ſagt in dem Liede der alte
doo alt zaacht in dame lee'-de dare al'-te
Krieger zu ſeinem Mantel. Vierzehn
kree'-gerr tsoo zy'-nem man'-tel fearr'-tsayn
Tauſend Mann wurden im Jahre ſiebzehn
tow'-sent mann voor'-den im yah'-re zeeb'-tsayn

hundert und acht und neunzig von den
hun'-dert unt acht unt noine'-tsich fon dane
Franzoſen nach Egypten geſchickt. In
frahn-tso'-zen naeh ay-yip'-ten ge-shikt' in
der großen Seeſchlacht von Aboukir am
dare gross'-en zay'-shlaeht fon ah'-bou-keer am
erſten Auguſt in demſelben Jahre
ayrss'-ten ow'-goost in dame-zel'-ben yah'-re
hatten die Engländer ſo wie auch die
hat'-ten dee en'-glen-der zo vee oueh dee
Franzoſen dreizehn Linien-ſchiffe
frahn-tso'-zen dry-tsayn leen'-yen-shif'-fe
dieſe hatten aber elf hundert und
dee'-ze hat'-ten ah'-berr elf hun'-dert unt
ſechs und neunzig Kanonen und eine
zex unt noine'-tsich kah-no'-nen unt i'-ne
Mannſchaft von elf tauſend zwei hundert
mann'-shafft fon elf tow'-sent tsvi hun'-dert
und dreißig Seelen, während jene nur
unt dryss'-ich zay'-len vay'-rend ya'-neh noorr
tauſend und zwölf Kanonen und acht
tow'-zent unt tsvoelf kah-no'-nen unt aeht
tauſend und acht und ſechzig Mann
tow'-sent unt acht unt zeeh'-tsieh mann
aufbieten konnten. Neunzig Jahre
owf'-bee-ten konn'-ten noine'-tsich yah'-re
alt, nach einer wiſſenſchaftlichen Lauf-
alt naeh i'-ner vis'-sen-schafft-lich-en lowff'-
bahn welche ſich über mehr als ſiebzig
bahn vel'-ehe sich ue'-ber mairr als zeeb'-tsieh
Jahre erſtreckte, ſtarb Alexander von
yah'-re er-strek'-te starrb ah'-lex-an'-der fon
Humboldt, in achtzehn hundert neun und
hoom'-bolt in aeht'-tsayn hun'-dert noine unt
fünfzig. Unter Heinrich dem Achten
fuenff'-tsich un'-ter hine'-rich dame ach'-ten
fing die Reformation in England an
fing dee ray'-for-mah-tsiown in enn-glant an
unter Eduard dem Sechſten wurde
oon'-terr ay-dou-art dame zex'-ten voorr'-de
ſie fortgeſetzt. Die große und ſchöne
zee fort'-ge-zetst dee gross'-e unt shoe'-ne
Hauptſtadt Dresden hat ungefähr hun-
howpt-statt drayz'-den hat un-ge-fairr' hun'-
dert und ſieben und ſiebzig tauſend
dert unt zee'-ben unt zeeb'-tsieh tow'-sent
Einwohner. Carl Eduard, der junge
ine'-voh'-nerr earrl ay'-dou-art dare yoong'-e
Prätendent genannt, war der Enkel
pray-ten-dent' ge-nannt war dare en'-kel
Jakobs des Zweiten; er ſtarb am dreißig-
yah'-kops des tsvy'-ten airr starp am dryss'-ieh-
ſten Januar, ſiebenzehn hundert acht
sten yah-nou-ahr' zee'-ben-tsayn hun'-dert acht
und achtzig in Rom. Auf Friedrich dem
unt aeht'-tsich in rome owff freed'-rieh dame
Erſten, der Rothbart genannt, folgte
ayrr'-sten dare rote'-bahrt ge-nannt' folg'-te
im Jahre elf hundert und neunzig. Sein
im yah'-re elf hun'-dert unt noine'-tsich zine
Sohn Heinrich der Sechſte, welcher ſchon nach
zone hine'-rieh dare zex'-te vel'-eher shone nach
ſieben Jahren ſtarb. Neunzehn Jahre
zee'-ben yah'-ren starp noine'-tsayn yah'-re
lang ſchmachtete der junge König
lang shmaeh'-teh'-te dare yung'-e koe'-nieh
Jakob der Erſte von Schottland in
yah'-kop dare airr'-ste fon shott'-land in
Engliſcher Gefangenſchaft. Ich habe es
en'-glish-err ge-fan'-gen-shaft ich ha'-be ess
dreien geſagt, damit es nicht vergeſſen
dry'-en ge-zaaeht' dah-mit ess nieht fer-ges'-sen
werde. Die Auſſagen zweier Männer
vairr'-de dee owss'-zah-gen tsvy'-errmen'-ner
ſind manchmal verſchieden.
zint maneh'-mal fer-shee'-den

COMMON TALK.

BY J. T. YOUNG.

I SHOULD like to urge every young man to acquire the art of expressing himself in ordinary and familiar conversation with ease, elegance, and precision. That this art can be acquired, may be taken for granted, though there is as much difference in ability in this respect, as there is in most things. Some persons appear to have naturally a great command of language, while others have so little aptitude for conversation that they can scarcely hold their own in any company. Admitting these differences, I am nevertheless convinced that, with very rare exceptions, every person might be, and every one ought to be, able to express himself in his mother tongue easily, accurately, and with a fair amount of elegance, which is very far from being the case with the majority of people.

Much of the slovenliness of common speech is due to downright carelessness. Men often talk as if it were mere waste of time to select their words or to adjust the arrangement of them, and they come tumbling out of the mouth as though they would of necessity fall into their places without further trouble. Hence we get imperfect sentences,

> "Deformed, unfinished, sent before their time
> Into this breathing world but half made up,"

and many utterances are really only disorderly aggregations of words, as much like grammatical sentences as heaps of bricks are like houses, or chance sounds like melodies: often the end of a so-called sentence has no relation at all to the beginning, and not infrequently it is broken off in the middle ignominiously, and has no end. A very little continuous care would almost always remedy this defect, for those who blunder on in this careless way through all their lives are generally capable of writing an intelligible and connected letter. That is to say, when they take the trouble to select and arrange their words, they can express themselves with accuracy and propriety. Lord Chesterfield, in one of his letters to his son, writes, "It is now fifty years since I have never spoken or written one single word without

giving myself at least one moment to consider whether it was a good one or a bad one, and whether I could not find a better in its place." A similar practice is recommended to any one who wishes to avoid the common inelegancies and incoherencies of conversation. He will soon find himself repaid for his trouble, and after a time cease to feel any embarrassment from the effort. There are numerous passages in Lord Chesterfield's letters on this point which would bear quoting, but I must content myself with one in which he speaks of Lord Bolingbroke as having "such a flowing happiness of diction, which, from care perhaps at first, has become so habitual to him, that his most familiar conversation, if taken down in writing, would bear the press without the least correction, either in method or style." I have quoted this sentence because, while it supplies an illustration, it suggests also a caution. "A flowing happiness of diction" in conversation is very desirable, but anything like "fine talking" is an utter abomination—to be repressed at all cost: it is even worse than fine writing. There is a fine talker in Shakespeare's *Love's Labour's Lost*, who never uses a simple phrase if he can help it, and whose conversation abounds in phraseology which is meant to be poetical. "Doth this man serve God?" the princess asks. "Why ask you?" says a companion. "He speaks not like one of God's making." is the reply. A sentence I feel sometimes inclined to apply to fine talkers. Slovenliness is bad enough, but the affectation of stilted phraseology is absolutely unendurable.

My main object, however, in this paper, is to enter a protest against an ugly habit which is far too common and far more mischievous in its consequences than is generally imagined—the use of "slang." I think that slang is not quite so much in favour as it was a few years back; and trust that as education spreads we shall hear still less of it; but it is sadly prevalent. I know that many people fall into its use unconsciously; they hear and imitate, without giving the matter a thought. Others indulge in slang because they think it adds piquancy to their talk, and because it gratifies a perverted sense of humour. When a workman enters a coffee-shop and asks for "Two doorsteps and a stinker," meaning thereby two thick slices of bread-and-butter and a herring, it is to be presumed that he discerns some picturesque force in the phraseology, which gratifies him, though it is not apparent to everybody. I do not know how far the word "stinker" would pass current for herring, but I do know that there are many hundreds of words to be heard in our workshops and offices, in the streets, and in circles where men are neither uneducated nor supposed to be vulgar, which are far worse because they degrade what they describe. Not long since I heard an inquiry intended to be sympathetic: "What is the matter with the poor fellow?—is he off his nut?" The reader will probably understand the question, and it is to be hoped will also see the vulgarity of the terms in which it was put, and how they lowered the whole tone of feeling. To make my meaning clearer, I give another illustration. If I say, "So-and-so got drunk and was fined five shillings and costs by the magistrate," I am understood to speak of an offence against society justly punished. If, however, I say, "So-and-so got tight, was lugged before the beak, and let in for five bob and costs," the facts remain the same, but the inference is altogether different. The slang conveys an impression that the speaker regards drunkenness as a trivial indiscretion, and an appearance before the magistrate as merely an inconvenience and not a serious disgrace. Indeed, slang synonyms for this particular vice are all but innumerable, and they are mostly of the same character—diminutives which reduce the social offence of intemperance to a triviality scarcely deserving censure.

I do not think, however, that slang is ever more offensive than when it is applied to describe domestic and social relationships. When a young couple are courting, it is a case of "spoons," when they marry they are "spliced," and the husband becomes my "old man," and the wife my "old woman," the children are of course "kids," and these if they are brought up strictly are said to "cop it if they don't mind their eyes." Their clothes are "togs," their food is "grub." But there is no use in going further through the list, and the task is not a pleasant one. There are really two languages current amongst us, one of which is made up of vulgarisms and slang—this latter being copious enough to furnish a tolerably complete vocabulary for all who care to use it. Its defects are that it has no adequate expression for a refined thought or feeling, or for a grand idea. It is low, coarse, and degrading; it vulgarises the man who uses it, the person to whom it is addressed, and the sentiment it is intended to embody, if that is capable of being vulgarised. It is against this I wish especially to guard every young man who reads these sentences. I would have him resolutely refuse to countenance slang of every kind, whatever it may be, and wherever he may meet with it. It is essentially the language of the ignorant, the vicious, or the thoughtless. Let them have the monopoly of it. If it were necessary to relapse into slang for the sake of vigour, point, or poetry, there would be some excuse for it; but this is very far from being the case. The man who cannot express his thoughts and feelings, whatever they may be, in good English, without slang, does not understand the capabilities of his mother tongue. The hideous grotesqueness of the vulgarisms of which I am complaining really weakens language, and cannot stand for a moment a comparison with the well formed and well expressed sentences which would be used by one who understood the language he professed to speak. "Nor do I think it a matter of little moment," said Milton two centuries ago, in words which deserve to be remembered, "whether the language of a people be vitiated or refined, whether the popular idiom be erroneous or correct. . . . I am inclined to believe that when the language in common use

in any country becomes irregular and depraved, it is followed by their ruin or their degradation; for what do terms used without skill or meaning, which are at once corrupt and misapplied, denote, but a people listless, supine, and fit for servitude?"

This passage has a wide application—so wide that it might serve as the text for a long discourse. I imagine, too, that very few of us are sufficiently on our guard against the habit which it condemns. Of "irregular and depraved" language enough perhaps has been said, but what about the "terms used without skill or meaning"? Suppose, to bring the matter home, the reader were to resolve—and carry out his resolution—for a given time, say for a month, never to use a word which he did not understand, that he could not explain, and which did not express with precision what he intended to say. I fancy he would be both a "sadder and a wiser man" at the end of his probation than he was before he made the experiment; and I think, too, that probably he would say much less during the month, and possibly think more, than he ever did in any previous month of his life. I am not supposing the reader to be less culpable than the majority of people, but I do believe that most persons would be the better if they could be induced to carry out some such suggestion as that which has just been made. It is quite possible that a man may think with clearness and precision, and yet be unable to express himself in appropriate language. I have tacitly admitted so much already. If some one, for instance, should say that he had had a "beautiful" dinner, it might be readily conceded that he knew what he meant,—that he had found the dinner "delicious," and would probably have said so if he had only happened to remember that it was the proper word to use. Unfortunately, however, very much of the vague and incoherent talk by which a thoughtful mind is pained faithfully represents the vague and incoherent thinking of the speaker; and coarse and vulgar talk the low and incurable vulgarity of those from whom it proceeds.

It is often said that man is raised far above the lower animals by the privilege of speech—which is with some qualification true enough—but it is also true that the dignity which it confers on man depends upon the extent to which speech itself is dignified by that which it expresses. There is nothing, so far as I know, in the mechanism of its throat and mouth which prevents the drover's dog from using language as forcible and perhaps as elegant as his master's, or the house dog from calling out "If you come here I shall bite!" instead of continuing his "Bow-wow," which, as the burglar knows, means precisely the same thing; but I confess I do not see how much higher in the scale of being the dog would be raised by the gift of speech, so long as he continued in all other respects dog-like. Nor would the possession of that gift render a sty less fitting to be the dwelling-place of a hog, so long as he remained a hog. It is therefore not so much mere speech which places men at the head of the animal creation, as the qualities which are made apparent by speech,—a reflection which suggests the well known warning, "By thy words thou shalt be justified, and by thy words thou shalt be condemned."

XXIX.

EGYPT (*continued*).

From the Twenty-first Dynasty to the Conquest —i.e. 1100 *to* 332 B.C.

THE throne after the death of Rameses XIII. was usurped by the high priests of Amon, who assumed the royal dignity. The first of these was Harhor. Nothing particularly worthy of record remains to be told of him. His successor was his grandson Painetem, whose wife was a princess of the deposed Ramessid line. The history of this and the following dynasties are most obscure. The Apis tablets at the Serapeum, recording the finding or death of a sacred bull or apis, often give information as to the duration of a dynasty, but none of them mention the twenty-first dynasty. The first king of the twenty-second, however, was Shishak, memorable from his mention in Scripture; it is at this period that Hebrew and Egyptian history run side by side. The revolt of Jeroboam, one of Solomon's officers, led to the march of Shishak on Jerusalem, with a great army, where he took and pillaged the city and temple (see 1 Kings xi. 14-40.). The reigns of his successors are unnoteworthy, except for the mention of the death of, and consequent search for, several sacred bulls. The twenty-second dynasty was closed by Shishanka III. Egypt had now fallen completely into the hands of the Ethiopians, and being divided into provinces or small states, was under the government of an Ethiopian monarch named Piankhi. The struggles of Egypt for freedom against her many and varied oppressors now began in the revolt of Tafnekt, whose rebellion was quelled by Piankhi, who marched upon the insurgents. Piankhi, though a conqueror, was not a tyrant; he appears to have been a beneficent monarch, and a worshipper of the god Amon. The twenty-third dynasty was called the Tanite, and lasted eighty-nine years. We know barely anything of this period. No Apis is recorded in the Serapeum during these years. The twenty-fourth consisted of a single monarch named Bokchoris, celebrated as a legislator; his sayings became very popular. He was taken prisoner by the Ethiopians under their king Sabaco, and burnt to death about B.C. 715.

Sack of Jerusalem.

Ethiopian rule.

Bokchoris.

The Ethiopian dynasty was now established in Egypt, and Sabaco was the first recognized king. He is mentioned by Herodotus. His successor, Sibahi, was in turn succeeded by

Tirharkah, who at once commenced a struggle, which lasted his lifetime, with Esarhaddon, king of Assyria, for the possession of Egypt. It was about this time that Esarhaddon organized Egypt as a subject kingdom, dividing the country into twenty districts. Dr. Birch points out that a very similar arrangement prevailed in Egypt under the Mamelukes in 1783, when the country was ruled by twenty-four beys.

Assyrian rule. The remainder of Tirharkah's life was passed in struggles against Assyria, sometimes partially successful; but he was finally quelled by Assurbanipal, the associate and son of Esarhaddon. The next two kings of this dynasty, Rutamen and Nutmianem, struggled against the Assyrian yoke, and though the latter alarmed the oppressors by his successes, he did not succeed in emancipating the country.

The principal monarch of the twenty-sixth dynasty was Psammetichus, who was one of the twelve kings forming a dodekarchy; they reigned peacefully each in his own domains, until alarmed by Psammetichus, who had fulfilled the prediction of an oracle, which declared that he should be sole monarch. They, evidently under the protection of Assyria, demanded his banishment; but he called to his aid Gyges, king of Lydia, and with the assistance of Greek mercenaries in brazen armour the king succeeded in expelling the Assyrians from Egypt for ever. Psammetichus rewarded his foreign troops by grants of permanent occupation at a place near Bubastus, which excited great jealousy amongst his own countrymen.

EGYPTIAN SCULPTORS AT WORK.

Egypt's whole attention had now to be devoted to defending her boundaries, and preventing the incursions of foreigners, from which she had suffered so much. This did not prevent the revival of the arts and the repair of the temples, which now reached a high pitch of perfection. A new form of handwriting was also introduced in this reign, superseding the hieroglyphic. Psammetichus must be considered as one of the most eminent of Egyptian monarchs.

Pharaoh Necho. His successor, Necho II., conceived the grand idea of joining the Mediterranean and Red Seas, now at last realized by the Suez Canal. He desisted, finding the work too arduous. His next enterprise was to attempt the circumnavigation of Africa; and by his orders the Red Sea was traversed, and the Mediterranean entered by the Straits of Gibraltar. Necho II., like his father, devoted some time to embellishing the temples and other works of art. The Pharaoh, Necho, in a campaign against the Assyrians, was attacked at Megiddo by the king of Judah; he then marched on Jerusalem, and exacted tribute from the city, deposing the son of the king who had presumed to attack him. Necho was defeated by Nebuchadnezzar of Babylon, in the attempt to defend his conquests. He reigned sixteen years, and was succeeded by his son, who reigned five.

Apries, the Hophrah of Scripture, now ascended the throne. He was distinguished for his bravery, and he endeavoured to retrieve the credit of Egypt in war. He favoured the Hebrews, at that time oppressed by the Babylonians, but was unable to give them any assistance at the siege of Jerusalem. Numbers of them, we read, emigrated to Egypt at this time, and among others the prophet Jeremiah. A rebellion in Egypt led to the assassination of Hophrah, and he was buried at Sais.

The next king was Aahmes II. He appears to have favoured the Greek population of Egypt, and seems to have opened the country to Greek commerce. He is distinguished for his public works: the great monolith, weighing 500 tons, brought from Elephantine to Sais, is a monument of his reign. It is said to have occupied 2,000 boatmen three years in transporting it.

Persian invasion. At the close of this monarch's reign, Cambyses, the cruel and sensual king of Persia, enraged by an artifice practised on him by Aahmes, marched on Egypt—not before the death of the king, which took place B.C. 527. Egypt fell before the arms of Cambyses, who converted the country into a Persian province, overwhelming the Egyptians with every species of insult, horror, and outrage—burning mummies, desecrating temples, and stabbing the sacred bull in the thigh. He put the king Psammetichus III. to death at the court of Persia, by compelling him to drink the blood of a bull—a mode of execution peculiarly repugnant to the Egyptians.

The accession of Darius to the throne relieved Egypt from the horrible tyranny of this monster. The rule of Darius was mild and beneficent. He endeavoured to complete Necho's canal. It was in this reign that the

battle of Marathon occurred (B.C. 490); the Egyptians, profiting by the defeat of Persia, revolted from its rule, —but not for long, for five years later (B.C. 485) Xerxes reconquered Egypt. In the time of his successor Artaxerxes, Egypt made a desperate struggle for freedom, calling in Greeks and Libyans to their aid. This revolt was quelled with some difficulty by the Persians.

Marathon.

Xerxes II. next ascended the throne. Both he and his successor Sogdianus reigned only a few months. After B.C. 425 we hear but little of Egypt; it still remained a Persian province. Mention is made of a king Amyrtaios, who was the only king of the twenty-eighth or Saite line; and the kings of the next or Mendesian dynasty vainly tried to overthrow the Persian rule.

The thirtieth or Sebennyte, or last dynasty, was founded by Nekhtherheb, who finally succeeded in expelling the Persians from Egypt, but not permanently. The arts attained great excellence in his reign. His son Getho or Teos had an unquiet reign, during which the army revolted. This led to the recall from Phœnicia of the last of the native Pharaohs; and the enterprise of the Persian ruler of his time ended in the reconquest of Egypt and its annexation as a Persian satrapy. As such it continued until Persia fell before the victorious arms of Alexander the Great (B.C. 332).

The last dynasty.

EGYPTIAN HEAD-DRESSES.

XXXIII.

PRACTICE.

WE shall now consider a convenient method of compound multiplication called Practice, which is often useful in the practical calculations which every one has to make in the ordinary affairs of every day. It is applicable in finding the value of a quantity, when the value of a *unit* of some one denomination of that quantity is known.

Suppose I wished to know how much I must pay for 20 tons of goods at £6 15*s.* 4*d.* a ton, I might find the price by multiplying £6 15*s.* 4*d.* by 20. But I might equally well make the payment in the following way—viz., by putting down first £6 for every ton, then 10*s.* for every ton, then 5*s.* for each, and finally 4*d.* for each ton. Now, Practice is a method of calculating the payment by supposing it to be made in this way.

Definition.—An "Aliquot part" of any quantity is a part which is contained an exact number of times in that quantity. Thus 3 is an aliquot part of 12, ∵ it is contained exactly in it; 5 tons is an aliquot part of 15 tons; 5*s.* is an aliquot part of £2.

The principle on which Practice depends is the following. If a quantity be separated into the parts which compose it (*i.e.* the parts which when added together make up the quantity), and if each of these parts be multiplied by any one number (*i.e.* all the parts being multiplied by the *same* number), then the sum of all the products so found will be the same as the product of the whole original quantity multiplied by the same number.

To explain this principle, suppose we have to multiply 24 by 7. Now, 24 may be separated into the parts 15, 6, and 3 (of course we could separate it into parts in many other ways; and any of these ways would illustrate the principle equally well).

We have then $24 = 15 + 6 + 3$

The principle asserts that 15 times 7, and 6 times 7, and 3 times 7 all added together are equal to 24 times 7—*i.e.* $(15 \times 7) + (6 \times 7) + (3 \times 7) = 24 \times 7$, which can be easily verified by the student.

Again, since £1 12*s.* 6*d.* is composed of £1, and 10*s.*, and 2*s.* 6*d.*, the principle asserts that 9 times (£1 12*s.* 6*d.*) = (9 × £1) + (9 × 10*s.*) + (9 × 2*s.* 6*d.*) The student can easily make and verify for himself any number of illustrations of the principle. Indeed, he has been making use of the principle, perhaps without knowing it, every time he has multiplied one number by another consisting of two or more figures, and his result would have been wrong very time if the above principle were not true.

Now, if we separate our original quantity into parts so chosen that each of them is an aliquot part, either of the principal unit or of some of the other parts, we can find the part products very quickly and easily.

To explain this we will take an example. Find the price of 30 tons at £1 12*s.* 6*d.* a ton.

Here we shall consider the price £1 12*s.* 6*d.* to be separated into the parts £1, 10*s.*, and 2*s.* 6*d.* Evidently 10*s.* is an aliquot part of £1, and 2*s.* 6*d.* is an aliquot part of 10*s.*

Now, 10*s.* = ½ of £1, ∴ 10*s.* for each ton would amount to half what £1 per ton would amount to.

Again, 2*s.* 6*d.* = ¼ of 10*s.*, ∴ 2*s.* 6*d.* for each ton would amount to one-fourth of what 10*s.* a ton would amount to.

If, then, we find the cost at £1 per ton, and take half of it, we have the price at 10*s.* a ton; and if we take one-fourth of that, we find the price at 2*s.* 6*d.* a ton. Now, if we add the three prices together—*i.e.* the price at £1, the price at 10*s.*, and the price at 2*s.* 6*d.*, we find the price at £1 12*s.* 6*d.*

The student may feel inclined to think that a method which takes so long to explain must be difficult to perform. But it is not so. We have taken pains to explain very fully the principles made use of, but their application is not difficult.

The whole operation may be written as follows :—

	£	*s.*	*d.*
Price at £1 per ton = 30 × £1 =	30	0	0
,, 10*s.* ,, = ½ of price at £1 =	15	0	0
,, 2*s.* 6*d.* ,, = ¼ ,, 10*s.* =	3	15	0
∴ price at £1 12*s.* 6*d.* =	48	15	0

Example (1).—Find the price of 35 tons at £4 11*s.* 3*d.* per ton.

We shall consider £4 11*s.* 3*d.* to be made up of £4, 10*s.*, 1*s.*, and 3*d.*

Price of 35 tons	Per ton	£	*s.*	£	*s.*	*d.*
@ £1 =				35	0	0
∴ ,,	£4 = 4 × 35	0 =		140	0	0
10*s.* = ½ £1 ∴ ,,	10*s.* = ½ of 35	0 =		17	10	0
1*s.* = 1/10 10*s.* ∴ ,,	1*s.* = 1/10 of 17 10 =			1	15	0
3*d.* = ¼ 1*s.* ∴ ,,	3*d.* = ¼ of 1 15 =			0	8	9
∴ Price at £4 11*s.* 3*d.* —*i.e.*, the sum of the part prices	=			159	13	9

The operation may be written more shortly thus :—

	£	*s.*	*d.*		£	*s.*	*d.*
10*s.* = ½ of £1	35	0	0	= price at 1	0	0	
	120	0	0	= ,,	4	0	0
	17	10	0	= ,,	0	10	0
1*s.* = 1/10 of 10*s.* ∴	1	15	0	= ,,	0	1	0
3*d.* = ¼ of 1*s.* ∴	0	8	9	= ,,	0	0	3
	159	13	9	= ,,	4	11	3

Example (2).—Find the price of 60 boxes of cigars at £3 12*s.* 8*d.* per box.

	£	*s.*	*d.*		£	*s.*	*d.*
	60	0	0	= price at 1	0	0	
£3 = 3 × £1 ∴	180	0	0	= ,,	3	0	0
10*s.* = ½ of £1 ∴	30	0	0	= ,,	0	10	0
2*s.* = 1/5 of 10*s.* ∴	6	0	0	= ,,	0	2	0
8*d.* = ⅓ of 2*s.* ∴	2	0	0	= ,,	0	0	8
	218	0	0	= ,,	3	12	8

Example (3).—Find the weight of 120 boxes, each box weighing 8 tons 4 cwt. 2 qrs. 7 lb.

	T.	C.	Q	Weight of boxes at	
	120	0	0	= 1 ton	per box
8 tons = 8 × 1 ton. ∴	960	0	0	= 8 tons	per box
4 cwt. = 1/5 of 1 ton. ∴	24	0	0	= 4 cwt.	,,
2 qrs. = ⅛ of 4 cwt. ∴	3	0	0	= 2 qrs.	,,
7 lb. = ⅛ of 2 qrs. ∴	0	7	2	= 7 lb.	,,
	987	7	2	= 8 t. 4 c. 2 q. 7 lb.	per box.

Example (4).—There are 145 lots of ground of 2a. 3r. 18p. each: find the whole area.

	A.	R.	P.	Area about	
	145	0	0	= 1 a.	each lot.
2a. = 2 × 1a. ∴	280	0	0	= 2a.	,,
2r. = ½ of 1a. ∴	72	2	0	= 2r.	,,
1r. = ½ of 2r. ∴	36	1	0	= 1r.	,,
10p. = ¼ of 1r. ∴	9	0	10	= 10p.	,,
4p. = 1/10 of 1r. ∴	3	2	20	= 4p.	,,
4p. = ,, ∴	3	2	20	= 4p.	,,
	415	0	10	= 2a. 3r. 18p.	each lot.

Example (5).—Find the value of 466 yards at 16*s.* 10½*d.* a yard.

	£	*s.*	*d.*		
	466	0	0	= cost at £1	a yd.
10*s.* = ½ of £1 ∴	233	0	0	= cost at 10*s.*	a yd.
5*s.* = ½ of 10*s.* ∴	116	10	0	= ,, 5*s.*	,,
1*s.* 3*d.* = ¼ of 5*s.* ∴	29	2	6	= ,, 1*s.* 3*d.*	,,
7½*d.* = ½ of 1*s.* 3*d.* ∴	14	11	3	= ,, 7½*d.*	,,
	393	3	9	= ,, 16*s.* 10½*d.*	a yard.

In each of these examples the student should carefully examine the parts into which the price has been divided, and satisfy himself as to the reason why those particular parts were chosen. The object always is to choose such parts as are convenient aliquot parts of some of the preceding parts. Thus, in the last example 10*s.* is chosen because it is ½ of £1. 5*s.* because it is ½ of 10*s.*, 1*s.* 3*d.* because it is ¼ of 5*s.*, and finally 7½*d.* because it is ½ of 1*s.* 3*d.* Of course we must take care that the sum of the parts is exactly equal to the whole price.

It is sometimes convenient to consider the given price as the *difference* of two prices instead of the *sum*.

Thus, in the first example we may consider £4 11*s.* 3*d.* as the difference between £5 and 8*s.* 9*d.*; then find the price at £5 and the price at 8*s.* 9*d.*, and subtract the one from the other; the difference will be the required price.

The work will stand thus :—

	£	*s.*	*d.*			
	35	0	0	= price at £1		
£5 = 5 × £1 ∴	175	0	0	= ,,	£5	
5*s.* = ¼ of £1 ∴	8	15	0	= ,,	5*s.*	
2*s.* 6*d.* = ½ of 5*s.* ∴	4	7	6	= ,,	2*s.* 6*d.*	
1*s.* 3*d.* = ½ of 2*s.* 6*d.* ∴	2	3	9	= ,,	1*s.* 3*d.*	
	15	6	0	= ,,	8*s.* 9*d.*	

Subtract this from £175, we have the price at {£5 − (8*s.* 9*d.*)}—*i.e.* at £4 11*s.* 3*d.*

The student must use his ingenuity to discover what aliquot parts are most convenient, as no general rule can be given.

The following tables are worth remembering; and the student well practised in fractions will be able to vary and combine these aliquot parts so as to meet any case he may have to deal with.

Tables of Aliquot Parts.

Money.

10*s.* = one-half of £1 = $\frac{£1}{2}$ or £$\frac{1}{2}$.

6*s.* 8*d.* = one-third ,, = $\frac{£1}{3}$,, £$\frac{1}{3}$.

5*s.* = one-fourth ,, = $\frac{£1}{4}$,, £$\frac{1}{4}$, or $\frac{1}{2}$ of 10*s.*

4*s.* = one-fifth ,, = $\frac{£1}{5}$,, £$\frac{1}{5}$.

3*s.* 4*d.* = one-sixth ,, = $\frac{£1}{6}$,, £$\frac{1}{6}$, or $\frac{1}{2}$ of 6*s.* 8*d.*

2*s.* 6*d.* = one-eighth ,, = $\frac{£1}{8}$,, £$\frac{1}{8}$, or $\frac{1}{4}$ of 10*s.*, or $\frac{1}{2}$ of 5*s.*

2*s.* = one-tenth ,, = $\frac{£1}{10}$,, £$\frac{1}{10}$, or $\frac{1}{5}$ of 10*s.*, or $\frac{1}{2}$ of 4*s.*

1*s.* = one-twentieth ,, = $\frac{£1}{20}$,, £$\frac{1}{20}$, or $\frac{1}{10}$ of 10*s.*, &c.

Again—6*d.* = $\frac{1}{2}$ of 1*s.* | 2*d.* = $\frac{1}{6}$ of 1*s.*
4*d.* = $\frac{1}{3}$ of 1*s.* | 1½*d.* = $\frac{1}{8}$ of 1*s.*
3*d.* = $\frac{1}{4}$ of 1*s.* | 1*d.* = $\frac{1}{12}$ of 1*s.*

Weight.

2 qrs. = $\frac{1}{2}$ of 1 cwt.
1 qr. = $\frac{1}{4}$ of 1 cwt.
16 lb. = $\frac{1}{7}$ of 1 cwt.
14 lb. = $\frac{1}{8}$ of 1 cwt., or $\frac{1}{2}$ of 1 qr.
7 lb. = $\frac{1}{16}$ of 1 cwt., or $\frac{1}{4}$ of 1 qr.
4 lb. = $\frac{1}{7}$ of 1 qr.

Similar tables can easily be constructed for measures of time and space, and the student may exercise himself usefully in doing so; but it is hardly worth while to learn by heart any except the money table above.

The examples we have hitherto given are instances of Simple Practice, in which the quantity whose price, weight, etc., has to be found consists of one denomination only. When the quantity whose price, weight, etc., is to be found consists of more than one denomination it is called Compound Practice.

Example of Compound Practice.—Find the price of 3 cwt. 1 qr. 5 lb. of tea at 16 guineas a cwt.

	£	*s.*	
	16	16	= price of 1 cwt.
3 cwt. = 3 × 1 cwt. ∴	50	8	= price of 3 cwt.
1 qr. = ¼ of 1 cwt. ∴	4	4	= ,, 1 qr.
4 lb. = ⅐ of 1 qr. ∴	0	12	= ,, 4 lb.
1 lb. = ¼ of 4 lb. ∴	0	3	= ,, 1 lb.
	55	7	= ,, 3c. 1 q. 5 lb.

Example. Find the cost of laying a telegraph wire for 17 miles 5 furlongs 6 poles at a cost of £20 18*s.* 1*d.* per mile.

	£	*s.*	*d.*	
	20	18	1	= cost of 1 mile
			10	
	209	0	10	
	146	6	7	
17 m. = 17 × 1 m. ∴	355	7	5	= cost of 17 m.
4 f. = ½ m. ∴	10	9	0½	= ,, 4 fur.
1 f. = ¼ of 4 f. ∴	2	12	3⅛	= ,, 1 ,,
5 p. = ⅛ of 1 f. ∴	0	6	6⅜	nearly = cost of 5 p.
1 p. = ⅕ of 5 p. ∴	0	1	3¾	,, = ,, 1 p.
	368	16	6¾	= cost of 17 m. 5 f. 6 p.

Miscellaneous Examples.

1. Find the weight of 130 boxes, supposing each box to weigh 13 tons 3 cwt. 3 qrs. 2 lb.
2. Find the price of 15 boxes of oranges at 9*s.* 7½*d.* per box.
3. Find the price of 4823 pairs of shoes at 5*s.* 3¾*d.* per pair.
4. In a village there are 53 houses, and to each house is attached 1 ac. 2 r. 13 p. of land: how much land is occupied altogether?
5. Find the value of 5742 yards of cloth at 14*s.* 2½*d.* per yard.
6. A library of 7329 volumes has cost, on an average, 3*s.* 4¾*d.* a volume: how much has been spent on it altogether?
7. In a shipment of glass 34,823 square feet were broken: how much did the damage amount to, the square foot of glass being valued at 1*s.* 2¾*d.*?
8. Find the value of 74 tons at £7 3*s.* 4½*d.* per ton.

VII.

Frictional Electricity (*continued*).

A very useful adjunct to the electrical machine is an "insulating stool." This consists merely of a piece of hard, well-seasoned wood, with four varnished glass legs. If a person stand upon such an insulating stool, and place one hand on the prime conductor of the machine while the latter is in action, sparks may be drawn from any part of his body by his companions. Here, of course, the body of the individual upon the stool becomes temporarily a portion of the prime conductor of the machine. When the spark is taken from the person on the insulating stool, he experiences the same pricking sensation as when he himself takes a spark from the prime conductor of the machine by placing his knuckle near it.

The insulating stool.

FIG. 19.

Perhaps the most useful kinds of apparatus for use with the electrical machine are those employed for the purpose of *condensing* the electricity obtained from it.

As we have already seen, there is a limit to the *tension* of electricity accumulated upon a surface, and when that limit is reached the electricity passes off, or, as we say, is "discharged" into the air. In order to increase the tension of the electricity which we obtain upon a surface, without causing it to discharge, we

Condensation of electricity.

employ several pieces of apparatus which condense it.

Of these the first which we shall describe is what is known as the "condensing pane," which was invented by Franklin.

The condensing pane.

This, in its simplest form, consists of a sheet of varnished glass, which has attached to it, near each end, a loop of tape by which it may be easily lifted. Beneath it is laid a sheet of tin-foil, and upon it another sheet somewhat smaller than the plate of glass. (See fig. 22.)

If now the upper sheet of tin-foil, A, be connected with a gold-leaf electroscope, F, by means of a piece of thin copper wire, a number of charges of electricity may be given to A by means of a proof plane, without in the least affecting the leaves of the electroscope. If, however, the upper sheet of foil, A, be raised by lifting the glass plate by the tape loops D and E, the leaves of the electroscope will immediately diverge.

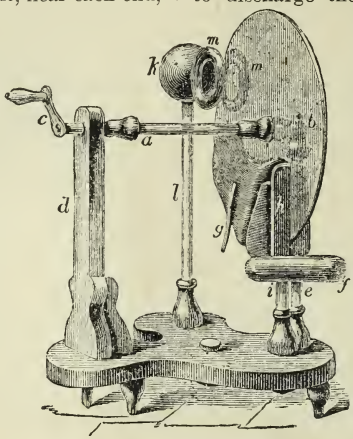


FIG. 20.—WINTER'S MACHINE.

The explanation of this somewhat curious fact is as follows. Suppose the electricity given to A to be *positive*. This positive electricity will act inductively through the glass plate upon the lower sheet of foil, C (which is connected with the earth by means of the wire G), and will decompose its neutral electricity, repelling its positive and attracting its negative. The positive electricity of A, therefore, will have opposed to it the negative of C, and will be attracted to it, bound captive by the very power which it has itself evoked. It is therefore powerless to affect the leaves of the electroscope, until it is removed from the influence of C by the raising of the glass plate B.

Principle of condenser.

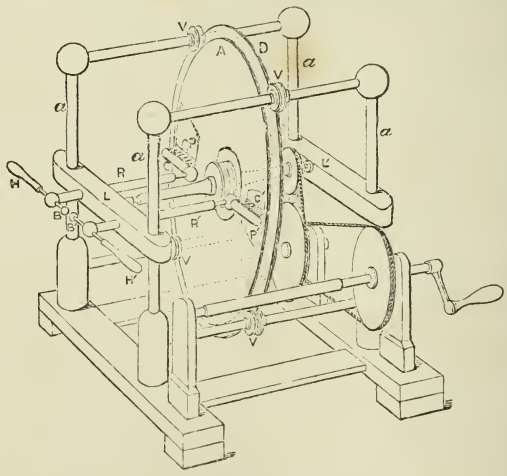


FIG. 21.—HOLTZ MACHINE.

With the electrical machine the condensation of electricity by Franklin's plate may be shown in a very striking manner.

Use of the condenser.

Let the upper sheet of foil be connected with the prime conductor of the machine by means of a piece of thin copper wire. Now turn the machine several times, so as to charge the plate, and, having done so, touch the upper sheet of foil with one hand, and bring the other hand near the lower sheet: a smart shock will be felt, and a bright spark of electricity be seen. Here the opposite electricities of the two sheets of foil unite through the body of the experimenter.

As it is not always pleasant or convenient to discharge the condensing pane and other similar electrified bodies by the hands, a pair of "discharging tongs" will be found useful. These are represented in fig. 23, and consist merely of two metal rods having brass balls at their ends and furnished with a glass handle or handles. In the figure 1 is for use with one hand, 2 requires two, and is used when the distance between the two points to be connected is considerable.

The discharging tongs.

In its permanent form, for use with the electrical machine, Franklin's condensing pane has the two sheets of foil the same size, but somewhat smaller than the pane of varnished glass. They are then pasted on to the glass, and the lower sheet has a small tongue of tin-foil passing from it over the edge of the glass so as just to reach the upper side. It is also convenient to make a long tongue to the upper sheet, and then to roll it round a varnished glass rod. By this arrangement the end of the upper sheet of foil may be brought any required distance from the tongue of the lower sheet of foil. This arrangement is shown in fig. 24, where V is the sheet of glass, C the tongue of the lower foil, B the upper sheet of foil, D the glass rod round which the tongue of B is rolled, E the wire connecting the lower foil with the earth, and F the wire by which B is connected with the prime conductor of the machine.

Another very important piece of apparatus for condensing electricity is the Leyden jar, fig. 25 (see Article VIII).

It will, of course, be easily seen that if we could take our condensing pane and roll it up so as to form a cylinder, we could, by putting a bottom to the cylinder, readily convert it into a jar coated on its inside and outside with tin-foil; and this is really what the Leyden jar consists of.

A wide-mouthed glass jar is taken, and, *being scrupulously clean and dry*, is carefully coated both inside and outside with tin-foil, with the exception of an inch or so from its neck. Into the top is fitted a disc of well-baked wood, and through this passes a stout wire, which terminates externally in a brass knob, and internally in a hook to which a small piece of brass chain is attached, which rests upon the bottom of the inside of the jar. The part of the outside of the jar which is not covered with tin-foil is coated with shell-lac varnish. It must be understood that both the outside and inside of the jar must be covered with tin-foil, including the bottom. The rod should be fastened to the wooden disc through which it passes by shell-lac.

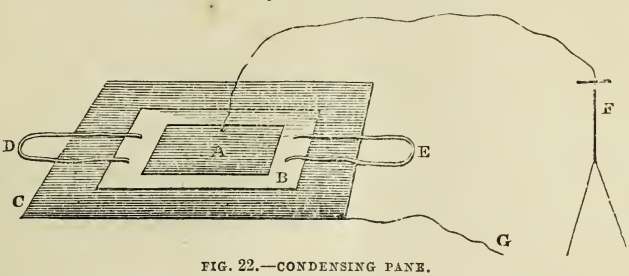


FIG. 22.—CONDENSING PANE.

To use the Leyden jar, hold it in one hand, and place its knob in contact with the prime conductor of the machine. After it has remained there a second or so, remove it, and touch the knob with the other hand; a smart shock and spark will be the result. If preferred, the jar can of course be discharged with the discharging tongs, (in which case be careful to touch the outside coating first), or if it is desired to give a shock to several persons at once, let them join hands; then let the person at one end hold the jar by its outer coating, while the person at the other end *touches the knob*. It will be readily seen that the action of the Leyden jar is precisely the same as that of the condensing pane, the inner coating of the jar corresponding to the upper foil of the pane, and the outer coating of the jar answering to the lower foil of the pane; consequently the inner coating of the jar is positively, the outer negatively electrified, and the union of the two kinds of electricity is rendered evident, when the two coatings are connected, by a spark.

How to use the Leyden jar.

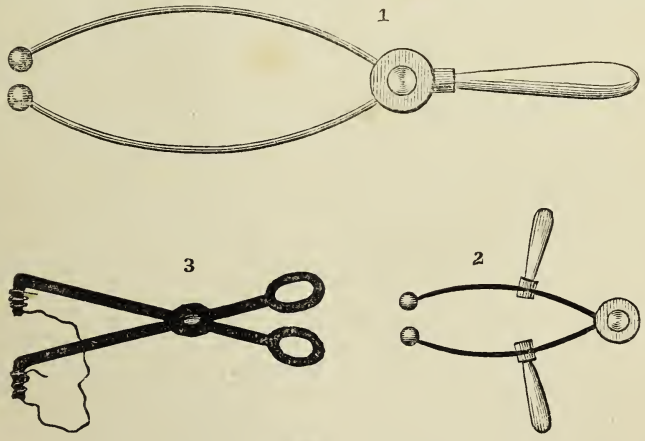


FIG. 23.—DISCHARGING TONGS.

Theory of the Leyden jar.

A curious phenomenon of the Leyden jar is the so-called "residual charge." If a jar be charged and then allowed to stand for a short time before being discharged, it will be found that a second, although very much smaller spark, may be obtained a short time after the first, and frequently at short intervals a third and even a fourth may be seen. These are the so-called "residual" sparks. They are usually explained by saying that the two electricities slightly, as it were, *soak* into the glass, being impelled thereto by the attractive force which they exert upon each other. When the jar is first discharged, the surface electricities, which form by far the larger portion, unite, and the jar being subsequently allowed to stand, the residual electricity oozes out again to the surfaces, whence it may be discharged. That this explanation is probably correct, is seen from the fact that a spark will sometimes pass through the glass of a jar if left standing for some time after being charged.

Residual charge.

The two electricities of a charged jar are generally supposed to accumulate upon the outer and inner surfaces of the glass, rather than upon the tin-foil coatings; and that this is the case, at any rate when the coatings are removed from a charged jar, may be shown by constructing a Leyden jar with movable coatings. This may be done in the following manner. Take a clear open glass, such as an uncut tumbler, and make a wooden cone so as to fit easily the interior of the glass, but not to quite fill it. (See fig. 26.) Cover this carefully with tin-foil, and fix to it a brass rod and ball, placing round the rod a small piece of varnished glass tube, so that the cone may be raised without touching either the tin-foil or the brass rod. This cone placed inside the jar will constitute its inner coating. The outer coating may be

made of thin cardboard covered with tin-foil on both sides, or, better still, may be made of sheet-iron tinned or zinc, and should be just large enough to allow the glass jar to slip easily (*but not too easily*), in and out. The surface of the jar above the coatings should be coated with shell-lac varnish. When these parts are placed together, the jar can be used in precisely the same manner as an ordinary Leyden jar.

Having constructed your jar, put it together and charge it in the ordinary way, and then stand it upon the table and connect its outer coating with the earth by means of a wire. Remove now the inner coating by catching hold of the varnished glass tube, and test it by means of the electroscope; it will exhibit only a very small charge of electricity, *if any*. Now take hold of the outer coating and shake out the glass jar, which proceeding will of course neutralize any electricity which the outer coating may possess, as by laying hold of the outer coating you connect it at once with the earth. Having done this, proceed to rebuild your jar by placing the outer coating over the glass, and, after inverting the latter, place in it the inner coating, lifting this of course by the varnished tube. If you now join the inner and outer coatings, a spark, almost if not quite as bright as the ordinary one, will be obtained. This experiment without doubt clearly shows that when the metallic coatings of a Leyden jar are removed the electricity almost entirely stays upon the glass.

Experiment with Leyden jar.

When large quantities of electricity are required, several large jars are employed, having their internal and external coatings respectively joined together. These are placed in a box lined with tin-foil, which lining is connected with two metal handles in the sides of the box. The inner coatings are all connected together by metallic rods, and the battery is charged by placing the internal coatings in connection with the prime conductor of an electrical machine, and by connecting the external coatings with the earth by means of a chain which is attached to the handles of the box. Such an arrangement of Leyden jars is known as a Leyden jar battery, and is shown in fig. 27 (Article VIII.). From these batteries extremely powerful discharges may be obtained, and they should invariably be discharged by means of a discharging rod, *the outside coating being first touched*.

Leyden jar batteries.

Beside the arrangement described above, a series of jars may be arranged in what is termed a "cascade." In this case the jars are placed each upon a separate insulating support, and the knob of the first is placed in connection with the prime conductor of the machine, while its outer coating is connected with the knob of the second, the outer coating of the second with the knob of the third, and so on; the outer coating of the last being connected with the earth. The first inner coating becomes positively charged, and acts inductively upon the first outer coating, which latter discharges its free positive electricity, not, as in the ordinary way, to the earth, but to the inner coating of the second jar, which thus becomes positively electrified, and in like manner passes on a charge to the third jar, and so on. The jars may be charged singly, by connecting the inner and outer coating of each jar, or simultaneously, by connecting the inner coating of the first with the outer coating of the last. A little consideration on the part of the reader will enable him to see that by this arrangement the same quantity of electricity which would, in the ordinary way, charge only one jar, is made available to charge several.

Cascade arrangement.

XXVII.

The Pronoun (*continued*).—Theory.

1. *The personal pronoun used as subject to the verb.*—The *conjunctive* forms *je, tu, il, elle, nous, vous, ils, elles,* stand immediately after the verb in interrogations, quotations, and in a few phrases where the construction supplies some conjunction. Besides this, certain adverbs and conjunctions beginning a proposition, make it optional to place the *subject-pronoun* before or after the verb. Examples:—

a. Interrogation: Que ferai-je? *what shall I do?*

(For further information revise the chapter on Interrogation, Universal Instructor, vol. ii. p. 6.)

b. Quotation: Non, vous dis-je, *no, I tell you.*

(This is also the rule when a noun is the subject: Non, répondit Jean, *no, John replied.*)

c. Construction supplying conjunction: Nous irons, dussions-nous périr, *we shall go, even though we should perish.*

(Dussions-nous = quand même nous devrions.)

d. Case of option: Peut-être vous dira-t-il, *or* peut-être il vous dira, *perhaps he will tell you.*

(Some of the other expressions permitting this inversion are: *à peine,* hardly; *aussi,* therefore, so; *au moins, du moins,* at least; *combien,* how; *encore,* yet, even then; *en vain,* in vain; *toujours,* anyhow; etc.)

2. The *disjunctive* forms are *moi, toi, lui, elle, nous, vous, eux, elles.* These, as it has already been mentioned, are used apart from the verb, either because the verb is understood, or because some word—other than the negative particle *ne* or some objective pronoun—intervenes. They are used:

a. In answering a question, or asking it: Qui a fait cela?—Moi; *who did this?—I.* Qui? lui, madame?—Lui; *who? he, madam?—He.*

b. In an exclamation or apostrophe: Toi aussi, Brutus! *you too, Brutus!* Moi, seigneur, moi, que j'cusse une âme si traîtresse (Racine). *I, my lord, I, that I should have so false a soul!*

c. In comparisons: Nous sommes moins heureux qu'eux, *we are less happy than they;* Qui, plus que lui, aurait besoin de consolation? *who more than he would require comfort?*

d. When forming a predicate after *être:* Qui est-ce?—C'est ELLE, c'est NOUS, ce sont EUX ; *who is it?—it is she, it is we, it is they.*

Remark.—When the pronoun-predicate of the 3rd person replaces things, its forms are no longer *lui, elle, eux, elles,* but *le, la,* and *les: Est-ce le canif?—ce l'est,* is it the penknife? it is ; *Est-ce que ce sont les cuillers?—ce les sont,* are they the spoons?—they are.

c. When a verb has several subjects expressed by personal pronouns, or personal pronouns joined to nouns :

ELLE et LUI se donnaient la main, *she and he were joining hands.*

Virginie et LUI couraient sur la grève, *Virginia and he were running on the strand.*

(The subjects being of different persons, the verb is put in the plural of that person which possesses priority—the first having precedence of the 2nd and 3rd, the second, of the 3rd : *Vous, Paul et moi courions,* you, Paul and I were running ; *Toi et ta sœur viendrez,* you and your sister will come. In such cases it is usual to sum up the various subjects into the plural pronoun of the person having precedence : *Vous, Paul et moi,* NOUS *courions ; Toi et ta sœur,* VOUS *viendrez.*)

f. Followed by a relative pronoun, present or past participle, or adjective :

Toi qui parles si haut, *thou who speakest so loud ;*

Lui payé, il ne me restera rien, *he being paid, nothing will remain to me.*

Eux seuls restent inflexibles, *they alone remain unbending.*

g. When pointing out the part taken in an action by various persons, or in contrasting their position (antithetical construction) :

Il gage que c'est moi, et MOI, je gage que c'est lui (Molière), *he wagers it is I, and I wager it is he.*

MOI, je vais vous porter, VOUS, vous serez mon guide (Florian), *I am going to carry you, and you shall be my guide.*

h. When repeated for the sake of emphasis (pleonastic use of the pronoun) :

Mais je prétends, MOI, vous rendre un bon office (Molière), *I intend, for my part, to do you a good turn.*

(In such a case the pronoun is often followed by *même. O bienheureux l'enfant, que le Seigneur daigne instruire* LUI-MÊME! (Racine), O happy is the child whom the Lord deigns Himself to teach! It will be seen that the antithetical construction is likewise pleonastic—and here we have one of the substitutes for *accent ;* see p. 535, Vol. I.)

Remark.—In reviewing the above eight cases of the use of the disjunctive form, the student will be reminded of the marked tendency colloquial English betrays with regard to it : My brother and *me,* etc., etc. Whatever may have been said in favour of such a practice, contemporary native grammarians condemn it ; this enables us to formulate the axiom that *in all cases when me, him, us, etc., are bad grammar in English, they are indispensable in French.*

3. *The personal pronoun used as a direct object to the verb.*—In addition to what has been said of this point (see p. 139) it must be observed that—

a. Of two imperatives joined by *et* or *ou,* the latter may have its object placed *before* it:

Battez-le et le rebattez, *beat it and beat it again.*

Acceptez-les ou les refusez, peu importe, *accept them or refuse them, it matters little.*

b. If the verb governs several pronouns they are put after it in the disjunctive form :

Le gouverneur recevra moi, toi, et les autres, *the governor will receive me, thee, and the others.*

4. *The personal pronoun used as an indirect object to the verb with* à *understood.*—To this case the two remarks which precede apply :

a. Vous attendez le roi ; parlez et lui montrez contre le fils d'Hector tous les Grecs conjurés (Racine), *you are waiting for the king ; speak and show to him all the Greeks conspiring against the son of Hector.*

b. Le gouverneur écrira à moi, à toi, et aux autres, *the governor will write to me, to thee, and to the others.* (But it is seen that here *à* can no longer be understood.)

c. Although *à* is understood with many verbs, it cannot be understood with all, and the following verbs and phrases require *à* with the disjunctive form of the pronoun to be placed after them : *aller,* to go ; *courir,* to run ; *accourir,* to run up ; *en appeler,* to appeal ; *avoir affaire,* to have to deal with ; *avoir égard,* to respect ; *avoir rapport,* to refer ; *avoir recours,* to apply ; *être,* in the sense of to belong ; *faire allusion,* to allude ; *faire attention,* to mind ; *marcher,* to walk ; *parvenir,* to reach ; *penser,* to think ; *prendre garde,* to be on one's guard ; *songer,* to think ; *venir,* to come ; *revenir,* to come back ; *viser,* to aim ; *voler,* to fly, etc.

EXAMPLES.

Ils coururent à lui, *they ran to him ;*
Vous aurez affaire à moi, *you will have to deal with me ;*
Ce chien est à elle, *this dog belongs to her ;*
Tes parents pensent à toi, *thy parents are thinking of thee ;*
Sentinelle, prenez garde à vous, *sentinel, watch!*

One could not say : *ils* lui *coururent, vous* m'*aurez affaire, ce chien* lui *est, tes parents* te *pensent,* etc.

d. In connection with this third position of the personal pronoun (viz. indirect object by *à* understood), it will have been observed that no reference as yet has been made to the 3rd person, when it replaces things. For this particular case the French use a so-called adverbial relative pronoun—namely, *y.* which comes from the Latin *ibi,* there. [It is not used exclusively of things ; it may apply to animals and people : *ce cheval mord, n'y touchez pas,* this horse bites, do not touch (to) him ; *la haine entre les grands se calme rarement ; la paix souvent n'y sert que d'un amusement* (Corneille), hatred among the great seldom cools ; peace with them often is but a make-believe.]

It may be variously rendered into English : first, in its nature of an adverb, by *there ;* then by *to it, to them, at it, at them, in it, in them, therein ;* and—as persons are not excluded—by *to him, to her, at him, at her,* etc. [Let here the fact be well grasped, that it is immaterial what preposition is used in English, or whether a preposition is used at all ; the question—and also the difficulty—is to know whether the verb of the phrase demands *à* in French.]

EXAMPLES.

Vous vouliez y être, vous y êtes, *you wished to be there, you are there;*
Elle veut se rendre au bal, qu'elle y aille, *she desires to go to the ball; let her go there* (or *to it*);
La faim fait un trou dans le cœur du peuple et, y met la haine (V. Hugo), *hunger makes a hole in the people's heart, and puts hatred there* (or *into it*);
Tous les jours vont à la mort, le dernier y arrive (Montaigne), *all days lead to death, the last reaches* (*to*) *it;*
L'apparence souvent abuse qui s'y fie (Corneille), *appearance often deludes him who trusts it* (*trusts himself to it*);
Ses malheurs l'accablent; il y songe sans cesse, *his misfortunes overwhelm him; he always broods over them.*

The following phrase, culled from one of Mme de Sévigné's letters, shows that *y* not only may have a person for its antecedent, but also that it has been used for other persons than the third: *quoique je parle beaucoup de vous, ma fille, j'y pense encore davantage jour et nuit*, although I speak much of you, my daughter, I still more think of you day and night.

e. French possesses another adverbial relative pronoun: *en*, from the Latin *inde*, thence. It may have a person, animal, thing, or even a whole phrase, for its antecedent; and it forms to the verb an indirect object by *de* understood. In its character of an adverb it is rendered by *thence;* as a pronoun by *of* (or *about*) *him, her, it, them; from him, her, it, them; for* (or *by*, or *with*) *him, her, it, them; some* or *any of it, some* or *any of them;* etc. [We repeat the truism given in connection with *y:* the regimen of the English verb must be overlooked; for your guidance as to the appropriateness of *en*, see whether the French verb required for your phrase governs *de*.]

EXAMPLES.

Vous allez à Lyon, j'EN viens (Littré), *you are going to Lyons, I come thence* (or *from it*);
Nourri dans le sérail, j'EN connais les détours (Racine), *having been raised in the seraglio, I know the windings of it* (or *its windings*);
Néron, bourreau de Rome, EN était l'histrion (Delille), *Nero, Rome's executioner, was the buffoon of it* (or *was also its stage-player*);
Qu'avez-vous fait pour être gentilhomme? croyez-vous qu'il suffise d'en porter le nom et les armes (Molière)? *what have you done to be* (*reckoned*) *a gentleman? Think you it is enough to bear the name and weapons of one?*
J'adore Adélaïde, et j'en suis estimé (Piron), *I worship Adelaide, and I am esteemed by her.*
Ah! voici les fagots; qu'EN demandez-vous, *ah! here are the faggots; what do you charge for them?*
La crainte de faire des ingrats ou le déplaisir d'EN avoir trouvé, ne l'ont jamais empêchée de faire du bien (Fléchier), *the fear of meeting ungrateful people, or the pain of having met some, never hindered her from doing good.*
Voyez ces fleurs; en avez-vous cueilli (Littré)? *see these flowers; have you gathered any* (*of them*)?

Remark I.—As to place, *en* follows the same rule as all other pronouns: *j'en parle*, I speak of him, her, it, or them; *je n'en parle pas; en parlé-je? n'en parlé-je pas? Parlons-en; n'en parlons pas.*

Remark II.—When, in the imperative affirmative, *en* (also *y*) comes after the 2nd person sing., this, for the sake of euphony, takes an *s* in verbs of the 1st conj., and verbs in *ueillir, frir, ouvrir: il y a des cerises sur cet arbre—cueilles-en* (but *n'en cueille pas*), there are cherries on this tree—gather some; *voici l'arbre—cueilles-y des* (but *n'y cueille pas de*) *fruits*, here is the tree—gather some fruit off it.

XXXIII.

France under Richelieu and Mazarin (*continued*).

During the greater part of his career Richelieu could boast a faithful and congenial follower and servant in the person of the Capuchin Father Joseph, who thoroughly entered into his policy and ably seconded his schemes. At his death he left to his friend and pupil, Cardinal Mazarin, who entered the state council on the day of Richelieu's death, the task of continuing the system of government he had founded. Louis XIII., who left a child of four years heir to the throne of France, appointed a council of regency, with Mazarin at its head, to rule the country during the minority of the little Louis XIV. To his queen, Anne of Austria, a very subordinate place had been allotted in the arrangement; but Anne, popular alike with the nobility and the parliament, who were moreover disinclined to see Richelieu's policy carried out to its natural result—the annihilation of their own importance and power—suceeeded in getting the will set aside, and assumed the whole responsibility of the regency. But no sooner was she in possession of full authority as regent, than, to the angry surprise of nobles and parliament, she bestowed her whole confidence upon Cardinal Mazarin, thoroughly identifying her interests with his, and finding her account in the unwavering fidelity and attachment of the astute and diplomatic cardinal. Furious at their defeat, the nobles united with the parliament as the bitter opponents of Mazarin; and it was only by a truly machiavelian talent for intrigue, and by the judicious advantage he took of his enemies' blunders and dissensions, that the cardinal triumphed, after an arduous contest of ten years. So long as the Thirty Years' War in Germany continued, and the general attention was engrossed by external affairs, Mazarin's rule, which involved increased and oppressive taxation, was endured, though not without audible mutterings of discontent; but after the conclusion of that great struggle the opposition of the nobles and parliament developed into the war of the Fronde, the last contest in France against the establishment of despotism. The name "frondeurs," or slingers, given to the insurgents in this contest, was a term of contempt, indicating that their rising was unimportant and reckless as that of a troop of boys armed with slings. The most formidable of Mazarin's opponents was the powerful and ambitious Paul de Gondi, Cardinal de Retz, who made common cause with parliament and citizens to procure the dismissal of Mazarin. The Prince de Condé, the victor of Rocroi and

Father Joseph.

Louis XIV.'s minority, 1643.

Anne of Austria and Cardinal Mazarin.

The "Fronde" riots, 1646-53.

Sens, the greatest soldier of his time, though at first honoured with the confidence of Anne of Austria, who trusted to him to defend her against the rebellious Parisians, wavered in his allegiance, impelled to act against the court by his inextinguishable hatred against the cardinal; and behaved with such haughtiness to the court that Anne was induced to make a temporary alliance with the Fronde, which enabled her to send Condé, his brother Conti, and his brother-in-law the Duc de Longueville —the lion, the fox, and the ape, as the Duc de Bourbon sarcastically called them—prisoners to Vincennes. The Duchesse de Longueville, Condé's sister, the keenest diplomatist and the most thorough partisan of De Retz, tried her utmost to procure the liberation of the prisoners; party in a combat in the faubourg St. Antoine, near Paris, was obliged to quit the capital and to ally himself with Spain, whereby he incurred the odium of treason. Mazarin returned in triumph to France, joyfully received at the gates of Paris by the young king and a number of courtiers; and with his return the cause of absolute monarchy supported by military power was established.

Mazarin's triumph over his enemies was complete. Condé was ultimately obliged to wander, an exile in Spain, until abject submission procured him restitution of his estates and permission to return to France. De Retz was first imprisoned at Vincennes and afterwards banished. The parliament was lectured and

Triumph of Mazarin.

PARIS FROM THE SEINE, A.D. 1650.

and so powerful a faction was brought together against Mazarin, that he was obliged for a time to quit France and take refuge in the territory of Cologne, where the elector hospitably placed the chateau of Brühl at his disposal. But the queen remained faithful to her exiled favourite, and followed the advice he transmitted to her concerning the government; while among his enemies there was no real union: for the nobles were fighting for their class privileges, and not for popular freedom; the parliament lacked resolution and definite purpose; and Condé, caring for neither nobility nor people, allied himself alternately with the court and its enemies, as the interest or whim of the moment dictated. Condé, vanquished by his rival Turenne, who led the troops of the court

Defeat of Condé.

threatened by the young king, who appeared before the startled assembly in his hunting boots, riding-whip in hand, and peremptorily demanded obedience. The Fronde war failed utterly, as was to be expected of a desultory contest waged by chiefs who distrusted one another and had no heart for the general cause; and all resistance to royal authority having been put down, the young king was enabled to say with truth "L'état c'est moi,"—I am the state. The end of Mazarin's career was especially prosperous. His influence over the young king was complete. He amassed a fortune of two hundred millions of livres. His power was as great as that of Richelieu, and like his great predecessor, he lived surrounded by splendour and by an obsequious crowd of followers and clients; among whom he moved like a king,

through halls rich with masterpieces of painting and sculpture; for the cardinal resembled the Medici in his love of the magnificent in art and decoration. Not the least among the various points of his good fortune was reckoned the fact that he died in the full glory of his latest political achievement—the treaty of the Pyrenees; leaving to the young king Louis XIV., then twenty-three years of age, an empire free alike from external enemies and internal faction—strong, vigorous, and full of hope for the future.

Mazarin's death, March 9, 1661.

XXXIV.

Syntax (*continued*).

Syntax may be practically divided into two parts—Syntax of Concord, and Syntax of Government.

The syntax of concord treats of such agreement or correspondence as exists between words related to each other in number, person, gender, or case. The syntax of government relates to the modifying influence exerted upon one word by another on which it depends. Thus, in the sentence *Alexander Magnus Darium, regem Persarum vicit*, we have examples of both the syntax of concord and the syntax of government; for in this sentence the adjective *magnus* agrees with the noun *Alexander* in gender, number, and case,—this is syntax of *concord;* and the *regem* is the accusative case, singular number, in apposition to *Darium*,—this is syntax of concord; and further, the verb *vicit* agrees with the subject of the sentence, *Alexander*, in number and person,—this is syntax of concord also; but *Darium* is the accusative case governed by the transitive verb *vicit*, and *Persarum* is governed in the genitive case as dependent on *regem*, and each of these cases is a case of the syntax of government.

The Syntax of Concord.

The First Concord—The Nominative Case and the Verb.

Rule 1.—A verb agrees with its subject or nominative case in number and person—as in *magister docet*, the master teaches. Here the verb *docet* is in the singular number, and in the third person, because its nominative case *magister* is in the singular number and third person.

Rule 2.—When two or more singular substantives form the joint subject, the verb is put in the plural number—as in *Hannibal et Philopœmon veneno absumpti sunt*, Hannibal and Philopœmon were carried off by poison. Here the joint subject is *Hannibal et Philopœmon*, two singular proper nouns; but the verb is in the plural to agree with the plurality of the subject.

But observe that when the subject consists of two singular substantives, which *together form but one idea*, the verb is in the singular—as in *Senatus populusque Romanus intelligit*, the Senate and people of Rome are aware. Here *Senatus populusque Romanus* form together *one idea*, and the singleness of idea is represented by the singular number of the verb.

Rule 3.—When there are two or more nominative cases singular, the plural verb always agrees with the nominative case of the most worthy person; and remember that the *first person* was considered by the Romans more worthy than the *second*, and the second more worthy than the third—as in (1) *Ego et tu sumus in tuto*, I and thou are in safety; (2) *Tu et pater periclitamini*, thou and thy father are in danger.

Here observe in (1), *sumus* is the first person to agree with *ego*, the first person, which is more worthy than *tu*, the second person; and in (2), *periclitamini* is the second person to agree with *tu*, the second person, which is more worthy than the third person, *pater*.

(Note that in Latin the first person always takes precedence of the second or third. Accordingly, when Cardinal Wolsey used to write *Ego et rex meus*, I and my king, he showed the good taste of a good classical scholar, but the bad taste of a courtier.)

Rule 4.—When the subject of the sentence is a collective, substantive, or noun of multitude, or an adjective implying plurality, the verb is often put in the plural, especially in the poets—as in Ovid, (1) *Tura ferant plācentque novum pia turba Quirinum*, let the pious crowd offer incense and appease the new (god) Quirinus; (2) *Missi sunt honoratissimus quisque ex patribus*, all the most distinguished (each of them) were sent from the Fathers (of the Senate).

Exercises on the First Concord and Apposition.

VOCABULARY (of words not before given).

Rhodanus (*m.*), the Rhone.	Galba (*m.*), Galba.
Rhenus (*m.*), the Rhine.	Cimbri, the Cimbri.
Jura (*m.*), the Jura.	Teutones, the Teutons.
Gallia (*f.*), Gaul.	Cassivelaunus, Cassivelaunus.
Piso (*m.*), Piso.	Avus (*m.*), grandfather.
Gabii (*m.*), Gabii, a town.	Quisque, each one.

Translate into English :—

Rhodanus flumen longum et latum est. Galli Romam, urbem pulcherrimam ceperunt. Mœnia urbis Romæ fortissima et altissima erant. Titus Cæsaris legatus, in prælio interfectus est. Galba, princeps potentissimus totius Galliæ, fines latissimos habebat. Cæsar copias Cassivelauni, ducis fortissimi Britannorum celeriter vicit. Romani montem Juram transiebant summâ diligentiâ. Dominus imperator gladium Gaio, servo fideli, dederat. Philosophi morum optimi magistri sunt. Philosophia morum magistra est. Oppidum Gabii captum est ab hostibus antiquissimis. Thebæ, urbs validissima, Bœotiæ caput est. Ego et Cicero, noster amicus, valemus. Tu et Tullia, nostra amica, valetis. Numa, rex Romanorum, vir erat

sapientissimus. Athenæ urbs omnium multò pulcherrima. Brutus Caiusque consules Romani vincebant. Doctissimus quisque adsunt.

Translate into Latin:—

My father and mother are dead. Camillus, the father of his country, is honoured. The city of Rome is set on fire. Cæsar, the general of the Romans, is marching with an army towards Mont Jura and the river Rhone. The river Rhone is long and broad and deep. The wars of Cæsar, the Roman general, were many and bloody. The town of Gabii was taken by the legions of the city of Rome. The muse is the inventor of sweet verses. You and your son are happy. Athens, a most illustrious Greek city, was utterly laid waste. The wall and the gate of the city of Gabii have been burnt down by fire. Each bad man has been banished from the city.

Questions for Self-Examination.

What is meant by syntax of concord, and what by syntax of government? Give an example of each. Write out the four rules given of the first concord—that is, the agreement of the nominative case and the verb. How do you account for the agreement of a singular verb with several nominative cases? Which is the most worthy of the three persons? What kind of nouns in the singular, and what kind of adjectives in the singular, sometimes take after them a verb in the plural number? and account for them.

The Second Concord—The Substantive and Adjective.

Rule 1.—The substantive agrees with its adjective or participle in gender, number, and case—*i.e.*, whatever is the gender, number, and case of the substantive, the same is the gender, number, and case of the adjective or participle in agreement with it—as in *Amicus certus in re incertâ cernitur*, a sure friend is discerned in a doubtful matter.

Here the adjective *certus* agrees with its substantive *amicus*, and the adjective *incerta* with *re*, because each is placed in the same number, gender, and case with its respective substantive—the former in the singular number, masculine gender, nominative case; and the latter in the singular number, feminine gender, and ablative case.

Observe that the rule of the agreement or concord of the adjective with its noun holds good whether the adjective is used as an attribute or a predicate—as in (1) *vir bonus*, a good man, where the adjective *bonus* is an attribute of *vir*, the noun; and in (2) *vir est bonus*, the man is good, where the adjective *bonus* is the *predicate*.

Rule 2.—Two or more substantives singular take a plural adjective, and in this case the adjective will be in the most worthy gender; and observe that the masculine gender is more worthy than the feminine, and the feminine more worthy than the neuter, when speaking of *living things;* but in speaking of things without life the neuter gender is most worthy. Thus in (α) *Rex et regina sunt beati*, the king and queen are supremely happy, the adjective is plural, as it qualifies two distinct persons, and is the masculine gender, as the most worthy when speaking of living persons; while in (β) *Arcus et calami sunt bona*, the bows and arrows are good, the adjective *bona* is plural to qualify two things, but neuter as the most worthy gender in things without life.

Rule 3.—When an adjective is used attributively of more than one substantive, it usually agrees with the nearest, and is understood with the others—as in *Omnes agri et maria*, all lands and seas; or the adjective is repeated, as is often the case in Cicero—as *Agri omnes omniaque maria.*

Rule 4.—When the substantive, though of the feminine or neuter gender, denotes male persons, then the construction being determined by the sense rather than by the sound, requires the adjective or participle to agree with the sense, and to be in the masculine gender—as in *Capita conjurationis percussi sunt*, the heads of the conspiracy were executed. Here observe that the substantive is *neuter*; but as it refers to persons, *percussi*, masculine plural, is made to agree with the *persons* implied in *capita*.

Rule 5.—Sometimes a predicative adjective, instead of agreeing in gender with the subject, is put into the neuter gender to agree with the Latin *negotium*, thing understood—as in *Triste lupus stabulis*, a wolf is a sad (thing) in the cattle stalls.

Rule 6.—Sometimes a sentence supplies the place of a substantive, and then the adjective or participle is put into the ablative case, and the *neuter gender* to agree with *negotio* (thing) understood—as in *Audito regem Doroberniam proficisci*, it having been heard that the king was setting out for Dover. Here *audito* is ablative neuter, to agree with *negotio;* now *the thing heard* was that the king was setting out for Dover.

Observe that there can be no adjective in a sentence without some substantive, either expressed or understood, agreeing with it. When no substantive is expressed, the adjective is put in the *neuter gender*, because the subject with which it is supposed to agree is not determined either to be masculine or feminine, and consequently is regarded as neuter. Very often adjectives agree with substantives not actually expressed, but yet clearly understood—as *amicus* (*vir*), a friendly man, that is, a friend; *dextra* (*manus*), the right hand; *regia* (*domus*), a royal house, and so a palace; *pauper* (*homo*), a poor man; *profundus* or *altum* (*mare*), the deep sea, and so the deep; *ferina* (*caro*), wild flesh, and so venison. As a parallel to this usage of the adjective for the substantive derived from the omission of the substantive originally in agreement, I may tell you that all our scientific terms in *ic* or *ics* were originally adjectives, though now used as substantives—as mathematics, optics, classics, hydrostatics, logic, physic, and arithmetic. These words were originally adjectives in agreement with art or science understood; but when the substantive was left out, they were left to represent and do duty for the substantive.

Exercises on the Second Concord.

Translate into English :—

Magna animalia longa nomina sœpè habent. Fortis militis pulcher cursus multos gravissimos casus habet. Multi et acuti ictus quercum altissimum occidunt. Domus nova novam porticum habebit. Ferocia animalia gratum gramen amare solita sunt. Rapidum fulmen timidum pecus terret. Antonius et Cleopatra voluptatibus indignis dediti sunt. Reges et reginæ adulatoribus blandis cœci facti sunt. Religio et philosophia sunt mortalibus optima. Tui libri et chartæ mihi gratissima erant. Omnia regna et regiones tuis laudibus plena sunt. Regna et regiones multæ tuum nomen laudabunt. Capita senatûs nostri sunt amplissimi et delectissimi. Duo millia Tyriorum crucibus affixi sunt. Decem millia militum Gallicorum virgis cæsi sunt consulis jussu. Turpitudo mihi videtur pejus quàm dolor acerrimus. Pœna omnibus qui patiunter grave est. Quàm triste est ignorantia. Audito consulem ad Romam venturum esse, milites celeberrimi conveniunt. Secundæ res, honores, imperia, victoriæ, fortuita sunt.

Translate into Latin :—

Philosophy is a blessed (thing) to all good (men). Ignominy is worse than the loss of wealth. All cities and kingdoms in the world will receive the news with the highest joy. Anger and avarice are too strong to be contented. Labour and enjoyment (*voluptas*) are linked together by a kind of partnership. My father and my mother are dead. The speech of Manlius, the consul, was approved of by all. The trees are good, and planted (*situs*) in the right place. The king and the queen are gentle in manners and illustrious in birth. If you and Tullia our delight are well, then the good husband and daughter are well. Two thousand of the Roman citizens were butchered by that one man. Fifteen thousand of our troops have been smitten with a sudden panic. A true friend is good (then). Punishment of vice is sad, and much to be lamented by all. Tell me what is more sad than to sin constantly against the truth and the best wishes of your best friends. It being heard that Cæsar is marching to Gallia, the leaders of the people assemble on the banks of the river Rhone. The venison is good and sweet. A part of the men has gone to the country.

Self-Examination Questions.

Learn off by heart and write out the rules for the second concord in Latin. Does the rule of concord in relation to the adjective depend on its being an attribute or a predicate? What gender is more worthy in the case of an adjective? How do you account for a *masculine* gender in the plural neuter after such words as *capita* and *millia?* Account for the neuter *triste* in *triste lupus stabulis*, and for *audito* in *audito regem proficisci Doroberniam.*

VI.

NEWTON'S FIRST AND SECOND LAWS OF MOTION.

§ 22. WE are now in a position to understand Newton's first law of motion; the substance of which has indeed been given in the preceding paragraphs. It is as follows:

Newton's First Law of Motion.

Every body continues in its state of rest, or of uniform motion in a straight line, except in so far as it may be compelled by external forces to change that state.

The property of matter implied in this law—viz., that a body cannot alter its own velocity—is called *inertia*. You must be careful, in using this word, to remember exactly what it means. The statement that inertia is a property of all matter does not imply what is meant by the common phrases "dead matter," "inert matter." We have indeed already had some examples of the wonderful effects produced by matter—effects which are none the less marvellous that they are simple; and bearing these in mind, we shall be cautious about describing matter as "dull," "dead." At all events, when we say that inertia is a property of matter, we do not imply that matter is dull or dead; for inertia is just as much a property of the body of a living animal as it is of a stone. We repeat, the statement means simply that a body cannot change its own velocity.

Inertia.

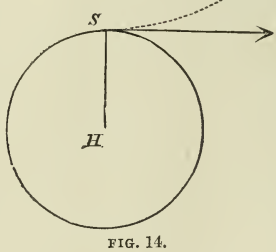


FIG. 14.

§ 23. One case in which inertia shows itself very markedly deserves notice; not so much for the interest attaching to it, as because of a certain misconception which prevails, or used to prevail, upon the subject. A stone is tied to one end of a string, the other end being held in the hand. If now the stone be swung round, it will describe a circle in the air, stretching the string so as always to be as far as possible from the hand. This fact was explained by means of a certain "centrifugal force"—a force, that is, which made the stone fly from the centre. But, as we shall see, we can very well explain the observation described above without assuming any "centrifugal force"; and some circumstances connected with the experiment are not consistent with the existence of such a force. The fact is, that "centrifugal force" is really another name for inertia, which is not a force at all. It was necessary to allude to the subject because the phrase, though misleading, is still in frequent use.

"Centrifugal force."

And now for an explanation of the experiment with the stone. In fig. 14 we will suppose H to represent the hand, S the stone, and the

straight line HS the string in one of its positions. When the stone is swinging round it will move along the circle shown in the figure. Suppose it has come to the top of its swing. It is then moving neither up nor down, but along the level line marked by an arrow. And we know—by the first law of motion—that it would continue to move in the same direction unless some force acted upon it. There must, then, be some force which makes the stone change the direction of its motion, so as to keep on the circle; and this force is clearly the pull of the string. This at once explains why the string gets taut; the string is continually pulling the stone out of its course, and it cannot pull without being taut. You will see, then, that we can explain why the string is stretched without assuming any imaginary force making the stone fly from the centre. We may even go further, and show that such a force cannot exist. For suppose the string were let go, then, if no force acted on the stone, it would go along the line SA; and if some force, making it go further from H, were to act upon it, it would go along some line (like the dotted line in fig. 14) further away from H than SA is. But we never find that the stone moves in this second way, and we are bound to conclude that there is really no "centrifugal force."

An experiment.

Another example is furnished by a railway train moving along a curve. In order to make the train change its direction, some force must be set to work. This is partly done by the rails, which press against the flanges of the wheels and so cause them to change the direction in which they are passing. But this is not enough; for if the wheels were made to move along a curve while the body of each carriage was tending to keep on in the same straight line as before, the result would very likely be that the carriages would topple over. To avoid such a catastrophe, engineers always make the outside rail of a curve a little higher than the inside rail, so that the train leans towards the inside of the curve. When the train is moving along the curve the earth pulls it towards the inside, and thus helps to change the direction of the train's motion. It is *not* to overcome a "centrifugal force," but to change the motion of the train, that these arrangements are required.

§ 24. We must now consider how forces are measured, and what particulars must be specified of a force to enable us to estimate its effect. Observe that we are only concerned with one kind of effect—a change of motion; and we know such a change completely when we know its direction and its amount. Accordingly, in particularizing any force it will be enough—at all events for the present—to indicate the direction and the magnitude of the force. On the former of these two characters it is unnecessary to dwell: the "direction of the force" is the direction of the change of velocity which it effects. But as to the magnitude of the force some explanation is required.

Comparison of forces. Direction of a force.

At first sight it might seem sufficient to measure a force by the change of velocity produced by it; but a little thought will convince you that it is necessary to make some stipulation about the time during which the force acts; for a small force can produce as great a change of velocity as you like, if it only acts long enough. We will, then, always suppose the force to act for a certain time—say one second—and then measure the change it has effected in the velocity of a moving body: in other words, we will measure the *acceleration* caused by the force. Will this be a good measure of the force? I think we must say no. It is true that the acceleration has been used as a measure of the force producing it; but the practice is getting less common, and there are strong reasons against it. For instance, consider the case of two or three strong horses employed in shunting a number of railway trucks. The acceleration they produce is comparatively small – smaller, indeed, than a child could easily produce in a perambulator it is wheeling. Shall we then say that the force exerted by the child is greater than that exerted by the horses? Yet that is what we must say, if we accept the acceleration produced as a measure of force. Again, if we were to estimate the amount of force by the acceleration effected, we should have to say that the force exerted by the earth upon a grain of sand is just as great as that which it exerts upon a ton of coal. Evidently, then, we have left something out; there is something else of which we must take account in determining the magnitude of a force. That "something" is the quantity of matter affected. The horses pulling at the trucks, as in our first example, will get a couple of empty trucks into motion with a certain effort; the same effort would produce a much smaller velocity if the trucks were loaded, or if there were a greater number of them. The weight of a grain of sand is able to cause a considerable acceleration if the grain be left to itself, because there is a very small quantity to move; and a load of coals will not fall faster than a single lump of coal, because, though there is a greater force acting on the load, yet this force has to set more material in motion. The force may be measured by the acceleration when equal quantities of matter are moved, but not otherwise.

Magnitude of a force.

§ 25. The question now arises: how is the quantity of matter—or mass, as it is called—to be taken into account? The reply may be inferred from an example. Suppose there are two precisely similar trucks, each pulled by a horse. The first horse pulls at his truck, and after a certain time he has made it attain a certain velocity; from which, as you know, we can calculate the acceleration or change of velocity in one second. If the second horse pulled with the same force at his truck, he would produce just the same acceleration, because the two cases are alike in every respect. It makes no difference if we suppose the two horses to be pulling at the same time; for then we should have double the quantity of matter (the two trucks) acted on by double the force (the traction of

Question and answer.

the two horses), while the acceleration would still be the same. So, if we required to communicate the same acceleration to three times the mass, we should require a threefold force; and so on. If the mass is multiplied, then the force required to produce a certain acceleration is also multiplied by the same number.

Determining the magnitude of a force.

An example will show how we apply this result to the determination of the magnitude of a force. A force which produces an acceleration 1 in a body whose mass is 1 shall be called a force 1, or the unit of force. Then a force which produces acceleration 5 in a body of mass 1 would be 5; because, the mass being the same as before, the force is measured by the acceleration it produces. Now, suppose a force produces an acceleration 5 in a body whose mass is 12. Then, as we have just seen, the force must be 12 times as great as a force producing the same acceleration in a body of mass 1: the force is 12×5, or 60. The result, then, is, that the magnitude of a force is found by multiplying the mass of the body moved by the acceleration produced.

Recapitulation.

It will be convenient here to recapitulate the substance of the preceding sections for reference:

The direction *of a force is the direction of the change of velocity caused by it.*

The magnitude *of a force is equal to the mass of the body acted upon, multiplied by the acceleration produced.*

Momentum.

§ 26. It will easily be seen that if we are told the direction and magnitude of a force, we can at once determine the effect the force will have on a given body. We have only to invert the two rules just given. "The change of velocity will be in the direction of the force," and "the acceleration produced multiplied by the mass will be equal to the magnitude of the force." Of these rules we shall give some examples soon. Before doing so, however, we will point out that they are equivalent to Newton's second law of motion. This law introduces a new and very useful word—*momentum*. Momentum is mass multiplied by velocity. A body whose mass is 3, moving with a velocity 5, has a momentum 15.

This explanation will enable you to understand the law of which we have been speaking. It runs thus:—

Newton's Second Law of Motion.

The change of momentum (effected in one second) is proportionate to the force applied, and takes place in the direction of that force.*

An example will show that this statement is equivalent to the two rules before given. Suppose a body, whose mass is 8, is moving with a velocity 7. Three seconds afterwards it has acquired a velocity 31 in the same direction. Here the momentum at first is 56: three seconds after, it is 248. The change of momentum in three seconds is 192, and in one second it is 64. If we take the rules given in section 26 we shall notice that the change of velocity in three seconds is 24, so that the acceleration—or change of velocity in one second—is 8. The mass multiplied by the acceleration is therefore 64, the same result as we obtained before for the change of momentum in one second. You will find that in every case the mass multiplied by the acceleration is equal to the change of momentum in one second—so that the rules in section 26 are, in fact, equivalent to Newton's second law.

* The words included between the parentheses are not in Newton's statement; but they—or some words equivalent to them—seem to be required to make the law accurate. Even this addition does not make the law exact for variable forces, and, to include this case, it should take the form—*The rate at which momentum changes is proportional to the force applied, and the change is in the direction of that force.*

XXXII.

THE MOON.

THE moon, from its close proximity to the earth, affords an opportunity for studying the physical condition of another member of the solar system under exceptionally favourable conditions. In the case of the moon, instead of being restricted to observing the broad features of their physical condition, which only afford us material for guessing at some of the more prominent features of their past history and future career, we can study the minuter details, and so learn much which gives a clue to the exact causes which have produced the effects we see. The observations of the moon possess, therefore, an interest and importance of their own, which lend to the study of selenography an exceptional charm. Nor is this charm decreased by the conviction soon acquired from the study of the lunar surface, that the forces which have brought the moon to its present condition are the same forces which have moulded the earth, so that on the lunar surface is written in the clearest characters the past history of our earth. This lends a great fascination to the study, for it creates for it an interest and importance which is possessed by the observation of no other member of the solar system. Much of the past history and future career of the earth might undoubtedly be learnt from observation of the physical condition of Venus, could we only see the surface; but we are restricted to seeing only the clouds in its skies, and these afford us no information as to the history of the planet beneath.

The moon moves round the earth in an elliptical orbit, whose greatest semi-diameter is 252,970 miles, and whose least semi-diameter is 221,610 miles, its mean distance from the earth being 238,840 miles. The constant or mean value of the equatorial horizontal parallax of the moon is therefore 57′ 2·325″. The eccentricity of this elliptical orbit is continually varying between small limits, owing to the disturbing action of the attraction of the sun

upon the moon in its motion round the earth ; but it continually fluctuates on either side of the mean value, 0·054908. The position of the lunar perigee, or point of the lunar orbit which is nearest the earth, is also continually moving, and makes a complete circuit of the orbit in 8·85 years ; for convenience, the mean position of the lunar perigee may be regarded as moving round the orbit with a uniform motion at the rate of 40° 40′ 31″ per year, and the actual position as vibrating to a small extent on either side of this mean position. The inclination of the lunar orbit to the ecliptic is equal to 5° 8′ 40″, but is subject to slight variation on either side of this value. The nodes of the lunar orbit move round the moon in the same manner as the position of the lunar perigee, but in the opposite direction ; for whilst the longitude of the perigee is continually increasing, the longitude of the nodes is continually decreasing, this decrease being at the rate of 19° 21′ 18″ per annum, taking 18·60 years for a complete revolution.

The mean sidereal revolution of the moon, or the time of one complete revolution round the earth, is 27 days 7 h. 43 m. 11·54 s., but its mean synodical revolution, or the mean duration of a month, is 29 days 12 h. 44 m. 2·68 s. The mean diameter of the moon is 31′ 8·00″, it ranging according to the varying distance of the moon from the earth between the two extremes of 33′ 33″ and 29′ 24″. Combining this with the known distance of the moon, it results that the actual diameter is 2163 miles. The surface of the moon is therefore only $1 \div 13{\cdot}43$ times that of the earth, and its volume only $1 \div 49{\cdot}20$. The mass of the moon is only $1 \div 81{\cdot}40$, so that its mean density is only 0·6042 of that of the earth, or equivalent to about $3\frac{1}{2}$ times that of water. Owing to this smaller mass and density, the action of gravity at the lunar surface is much smaller than on the terrestrial surface, being only equal to 0·1649 of the earth, or rather less than one-sixth.

As the moon takes the same time to rotate on its axis as it does to make a complete revolution in its mean orbit, it would always turn exactly the same face to the earth were both its axial rotation and orbital revolution made throughout with uniform velocity, and were the lunar orbit and equator in the same plane as the terrestrial orbit. But not only are the lunar equator and orbit inclined at small angles to the ecliptic or terrestrial orbit, but whereas the moon rotates on its axis at an almost absolutely uniform rate, it moves in its orbit with very different velocities in different parts and at different times. Accordingly the moon does not always present exactly the same face to the earth, so that instead of the apparent centre of the lunar disc being always at the same point on the lunar surface, it is ever swaying from one side to another of its mean place—the place it would invariably occupy were it not for the small angles made by the lunar orbit and equator with the ecliptic, and for the variable orbital velocity of the moon. This apparent swaying to and fro of the apparent centre of the lunar disc is called the *optical libration* of the moon, as it does not arise from any actual irregularity in the rotation of the moon upon its axis, but is an optical effect due to the inequalities in the motion of the moon in its orbit and to the inclination of its equator and orbit to the ecliptic.

The librations are measured in selenographical longitude and latitude, which are measured in exactly the same manner as terrestrial longitude and latitude—namely, longitudes are reckoned east and west from the lunar first meridian, and latitudes north and south from the lunar equator. West longitude and north latitude are usually called positive, and denominated by the sign +, and east longitude and south latitude are denominated by the sign —, and called negative. The first meridian is the great circle which passes through both poles of the moon, cutting the equator at right angles in the point which is at the mean centre of the lunar disc when there is no libration. This *libration* of the moon may amount to as much as 7° 54′ in selenographical longitude and 6° 51′ in selenographical latitude, the greatest displacement of the apparent centre of the moon being at times as much as 10° 25′.

From the effect of this libration we see at different times more than half of the entire lunar surface, as, owing to the effect of the libration, different portions of the edges of the further hemisphere are at different times brought into view. It has been calculated that in this manner we see at different times as much as 0·59 of the entire surface of the moon, only 0·41 part remaining invisible.

There is also a similar libration called the diurnal libration, and equal to the parallax of the moon, it being due to the same cause—namely, that we observe the moon from the surface of the earth and not from its centre, and so seeing the moon from a different position, see it in a somewhat different place.

When the moon is at its mean distance, one degree of selenographical longitude and latitude at the centre of the lunar disc subtends an angle of 16·6″ and measures 18·87 miles, so that under these conditions one second of arc is equal to 1·14 mile, and extends over 3′ 37″ of selenographical arc. As one second of arc is usually the smallest object which can be readily seen in an ordinary telescope, it follows that the smallest features to be easily seen on the moon must be about one mile in diameter. This may be compared with the 100 miles which is the diameter of the smallest spot to be seen on Venus, or 180 miles on Mars, the two most favourably placed planets.

When the lunar surface comes to be attentively studied with the aid of a good telescope, it will gradually become manifest that, though no copy of the earth, its structure is in every manner of identical nature ; everywhere will be found analogous manifestation of similar forces, and that the great formations of the moon are merely other examples and other forms of the great formations of the earth. In one respect, however, a very marked difference will be observed,—namely, that whereas the

formations of the moon seem to have retained their forms, dimensions, and character almost intact, as if they had only recently arisen, those on the earth are more or less completely ruined, having been much disintegrated, and being everywhere covered with *débris*, which usually nearly completely fills up all the depressions and cavities they had produced. The origin of this difference in condition is not difficult to see: the terrestrial formations have been ruined by the action of the great amount of water yet present on the terrestrial surface, and principally from the action of rain, which, falling everywhere, has gradually worn the formations down and filled them up by the *débris* produced. In the course of this action much of the water which the earth must have originally had free upon its surface in the form of oceans, seas, rivers, streams, and aqueous vapour, has now disappeared, being locked up by absorption in the upper-lying strata of the terrestrial crust. It has been calculated that nearly one-half of the water originally upon the surface of the earth has disappeared from the oceans and rivers, and been absorbed into the rocks and other material forming the surface of the earth.

FIG. 82.—FORMATIONS NEAR MOSTIG. LOW POWER.

Turning now to the moon, it is soon apparent that on its surface there are to be found neither oceans nor rivers; if there be any water on the lunar surface it must be in the form of aqueous vapour, and even then the quantity must be very small. If the moon had oceans, seas, rivers, what has become of them? Their absence will account for the more perfect condition of the lunar formation, for without them there can be no rain; but why should the earth have had oceans, seas, rivers, and the moon none? Further examination of the lunar surface supplies the probable answer to these questions. More critical examination shows numerous indications of the action of some disintegrating agent like water —like rain. It soon becomes evident that, though the lunar formations have not been more or less completely ruined, like those of the earth, yet they have by no means escaped all disintegration. Everywhere appear formations, especially those obviously of earlier construction to the greater number now visible, that have undergone exactly the same kind of disintegration, and have reached the same state of ruination which is universal upon the earth. We are not justified, therefore, in assuming that the moon has never had any disintegrating agent like the terrestrial oceans, rivers, and rains; in fact, further study will lead to the conviction that in times gone by there must have been such upon the moon. Then naturally arise the questions, Where are they? What has become of them? Why have they disappeared?

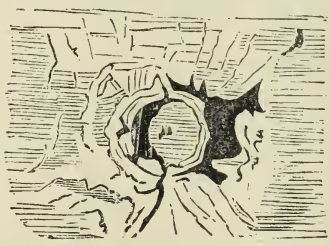


FIG. 83.—THE RING-PLAIN COPERNICUS, AS SEEN WITH SMALL MAGNIFYING POWER.

The answer is, they have been completely absorbed in the upper-lying strata of the lunar surface, in exactly the same manner as the upper-lying strata of the terrestrial surface has absorbed so great a part of the primitive terrestrial oceans. The primitive lunar oceans would probably bear the same proportion to the mass of the moon as the primitive terrestrial oceans did to the mass of the earth. As the mass of the moon is only $1 \div 81{\cdot}40$ of that of the earth, so would the amount of water in the lunar oceans be only about $1 \div 80{\cdot}4$ of the amount of water in the terrestrial oceans; but the surface of the moon is fully $1 \div 13{\cdot}5$ of the surface of the earth, so that for each square mile of surface upon the moon there would be only $13{\cdot}5 \div 81{\cdot}4$, or $0{\cdot}166$ part of the amount of water that existed upon the earth: in other words, upon the moon there would be six times as much surface to act upon a given quantity of water as there would be upon the earth. As, therefore, the surface of the earth has shown itself capable of absorbing nearly half the primitive terrestrial oceans, it is easily understood how the six times greater proportionate amount of surface has enabled the moon to absorb the entire amount of the primitive lunar oceans. This absorption would have taken place long ago, and so put a stop on the moon to the process of disintegration, which has continued to the present day on the earth, and has so produced the much greater effects which we find. On the moon, therefore, we find neither oceans, seas, nor rivers, neither clouds nor rain; because the lunar surface has absorbed all the water which formed the primitive oceans, seas, and rivers, and furnished the clouds and rain of the moon in its earlier days.

Has the moon an atmosphere? It is certain that it has not an atmosphere of the same density at the surface as the atmosphere of the earth. Such an atmosphere would reveal its presence in many ways, but principally in the refraction of the rays of light passing near the edge of the moon which it would produce at the times of solar eclipses and during the occultations of stars. But the force of gravitation at the surface of the moon is only one-sixth of the force at the terrestrial surface, so that any atmosphere on the moon would be condensed far less than on the earth, and would occupy far greater volume—more than eight times the volume. Moreover, as it would probably bear the same proportion to the mass of the moon as the terrestrial atmosphere bears to the mass of the earth, as we have seen in the case of the seas, it would have to be spread over more than six times the amount of surface. For this reason, even if the moon and earth had the same proportionate amount of atmosphere, the greatest density of the lunar atmo-

sphere would be only one-fiftieth of that of the terrestrial atmosphere. Careful observations have shown that any atmosphere possessed by the moon cannot exert refraction at the edge of the moon more than of two seconds of arc; and it is, therefore, certain that the lunar atmosphere has its greatest density less than two-hundredths of the density of the terrestrial atmosphere. It is probably, however, somewhat less dense than this: and the observations would lead to the conclusion that the greatest density of the lunar atmosphere was only $1 \div 350$ of the greatest density of the terrestrial atmosphere. Despite this very small density, the relative mass of such an atmosphere would be very considerable, as its greater volume would counterbalance its lesser density. This atmosphere would—it will readily be understood—be capable of very sensibly affecting the physical condition of the lunar surface.

Owing to the sun shining continuously upon the lunar surface for nearly fifteen days at a time, were it not for an atmosphere the lunar surface would acquire a very considerable temperature, probably as much as 500° centigrade. From experiments by Lord Rosse, it has been concluded that the real temperature acquired by the lunar surface does not exceed a fourth of this, the atmosphere shielding it. Even this is very likely an exaggeration, and the actual temperature of the lunar surface, it is not improbable, may not exceed 70° to 80° centigrade. Similarly, during a night of nearly fifteen of our days in length, the moon is continuously radiating away its heat into space; and it has been calculated that were there no atmosphere the temperature of the lunar surface would fall to an enormous degree, until it was far colder than anything ever known on the earth; to a temperature of — 200° centigrade. Yet the presence of this voluminous atmosphere completely alters this, despite its low density; for it would entirely shield the moon from directly radiating away its heat into space. Accepting even the experiments of Professor Tyndall on the absorption of radiant heat, it follows that all the heat radiated by the moon, after its temperature had fallen to 0°, would be absorbed by the atmosphere, and so the temperature of the surface would never fall much below zero. The experiments of other investigators on the absorption of radiant heat by gases would still more strongly confirm this view. The temperature of the lunar surface, therefore, probably ranges between 80° centigrade and — 20°,—a conclusion in accord with Lord Rosse's experiments on the temperature of the moon. Of course, in regions near the lunar poles the temperature would never rise nearly so high as 80° centigrade.

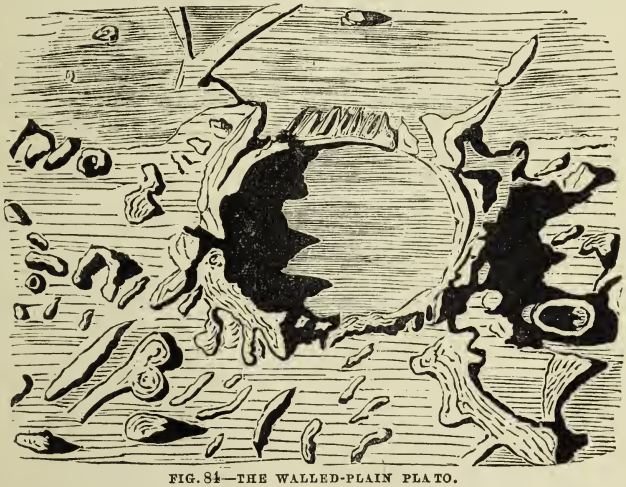


FIG. 84.—THE WALLED-PLAIN PLATO.

CHEMISTRY

XXXI.

LEAD.

THIS well-known and useful metal does not occur free in nature, but is met with in the form of a sulphide, termed "galena." To reduce the metal from this ore, the latter is first roasted in a furnace, with the addition of sufficient lime to form a fusible slag with the silica present. By the action of the air in combustion, a portion of the sulphide is converted into sulphate, whilst another portion is left behind in the form of lead oxide, after the evolution of the sulphur, in the form of an invisible gas, the dioxide. The air being now excluded, and the heat of the furnace raised, the sulphate and the oxides are finally decomposed and metallic lead is left behind. Galena is often found to contain traces of silver, sometimes in sufficient quantity to pay for its extraction.

Properties of lead.

Lead is a very soft metal, possessed of but little elasticity or tenacity, and melting at 334°. The surface of the metal is not oxidized in dry air, but soon becomes tarnished if moisture be present. Lead is not acted upon by perfectly pure water, free from air, but if air be present an oxide is formed slightly soluble in water.

Action of water on lead.

Since water in the natural state is never absolutely pure, or free from air, it is a matter of the utmost importance, before permitting any water intended for drinking purposes to come into contact with lead pipes or cisterns, to ascertain how far such water possesses the power of dissolving the lead compounds, all of which are highly poisonous. Hard water hold-

ing sulphates or carbonates in solution may be allowed to come into contact with lead without danger, as a thin deposit of sulphate or carbonate is formed on the surface of the metal, preserving it from further action. On the other hand, water containing much free carbonic acid should not be allowed to pass through lead pipes, as the carbonate formed by its action is soluble in water containing such acid. If the presence of lead is suspected, a current of sulphuretted hydrogen should be passed through a column of acidified water. The result will be the communication of a brown colour to the water, owing to the formation of lead sulphide, if any of the salts of that metal are held in solution by the water.

Action of hard water.

Water containing free carbonic acid.

Detection of lead in water.

Lead forms three oxides, the first of which, the monoxide, PbO, is commonly known as litharge. This oxide, uniting as a base with the acids, forms the series of the lead salts, which, when soluble, act as violent poisons. Lead oxide combines with silica to form a kind of glass or silicate.

Salts of lead.

Red lead, used as a pigment, is a compound of the monoxide and the dioxide of lead. It is used in the manufacture of glass. The poisonous soluble salt known as sugar of lead is an acetate of lead. The important pigment termed white lead is a compound of lead carbonate and lead hydroxide. This is prepared artificially by two different processes, one of which consists in precipitating the carbonate from a solution of nitrate of lead, and the other in the gradual conversion of the metal into its carbonate—effected in the following manner. Thin sheets of lead are rolled together and placed in earthen vessels containing a small quantity of crude vinegar—acetic acid. Successive layers, containing often hundreds of these pots, are stacked together in a chamber containing stable manure or the waste of tanyards; the acetate of lead formed in the first instance is by degrees converted into carbonate of lead by the action of the decaying organic matter, and is from time to time scraped off the coils of lead, until the whole has been converted into the carbonate or white lead. The metal thallium, which is placed in the same category as lead, is a metal resembling the latter in many of its attributes, but is of much rarer occurrence—indeed, it was only discovered, by means of spectrum analysis, less than twenty years ago. It melts at a point below red heat, and burns at a sufficiently high temperature in oxygen, with a bright green flame. This metal tarnishes or oxidizes so readily in the air that it has been found necessary to preserve it in water. The salts of thallium are too little used at present to need specification; suffice it to say that, like the lead series, the soluble ones are highly poisonous. Thallium may be regarded as forming a link between lead and the metals of the alkalies.

Red lead.

Sugar of lead.

White lead.

Manufacture of white lead.

Thallium.

Oxidizes readily.

The next group is a very important one, including, as it does, copper, mercury, and silver. The first of these, as giving its name to the series, must be allowed to take the precedence.

Copper group.

Copper.

This metal has been known from a very early period indeed. We are justified in assuming that mankind were acquainted with copper and its compounds before the discovery of the art of smelting or reducing iron from its ore. Copper is met with native in various parts of the world, but is principally obtained from the following ores:—Copper pyrites, a compound of copper, iron, and sulphur; cuprous or copper sulphide; cuprous oxide; and, lastly, the beautiful substance known as malachite, which is a carbonate of copper. These different ores are met with in various parts of the world, and the difficulty of reducing the metallic copper from its compounds varies with the nature of the latter, the process being much simpler in the case of the oxide and the carbonate than in that of the more complex pyrites.

Copper in use before iron.

Ores of copper.

Malachite.

Reduction of copper.

Copper, in the pure state, is of a deep-red colour, is very malleable and ductile, and possesses great tenacity. It melts at a red heat. Copper does not oxidize readily, nor does it decompose water vapour at a red heat. If heated to redness in air, however, it becomes coated with scales of copper oxide. Copper is readily attacked by nitric acid, with the evolution of red fumes and the formation of copper nitrate. Finely divided, copper dissolves in hydrochloric acid; if exposed to the action of hot sulphuric acid, copper sulphate is formed. Copper is a good conductor of both heat and electricity, although not in itself magnetic.

Attributes of copper.

Valuable as this metal undoubtedly is in itself, we should nevertheless miss many of its most important uses were we unable to alloy it with other metals. Pure copper, for instance, is at once too soft and too tough to work readily in the turning lathe, but when alloyed with about one-third of zinc we have the exceedingly useful compound known as brass. What is called Muntz's metal, used for roofing, sheathing ships, etc., contains about sixty per cent. of copper. Among the other important alloys of copper may be enumerated bronze, gun-metal, bell-metal, speculum-metal, etc. These alloys may be rendered by tempering either hard and brittle, or soft and malleable, as desired.

Alloys of copper.

Brass, Muntz-metal, bronze, etc.

Copper is a dyad element, and forms two classes of salts—the cuprous and the cupric salts—one of the most important of these being the sulphate, $CuSO_4$. This salt, commonly known as blue vitriol, crystallizes in large blue crystals, containing a considerable proportion of water. Copper sulphate is used in calico printing, and

Salts of copper.

also in the manufacture of Scheele's green, Brunswick green, and other pigments. When heated to redness this salt loses all its water of crystallization, and falls to an amorphous white powder. Cuprous oxide, Cu_2O, is used in staining glass, to which material it imparts a splendid ruby colour. The soluble copper salts all act as powerful poisons.

Uses of copper sulphate.

Ruby-coloured glass.

Mercury.

This remarkable metal, the only one liquid at ordinary temperatures, is sometimes met with in the native state, but is chiefly obtained from the ore known as cinnabar, which is its sulphide. Mercury is exceedingly volatile, being condensed from the gaseous state, in which it is evolved by the destructive distillation of its ores into the metallic form by passing through cooled earthen pipes. Mercury becomes solid at $-40°$, in which state it is malleable, and is about fourteen times as heavy as water. In other words, the fusing point of this metal is 40° below freezing point. Mercury gives off a certain amount of vapour at all temperatures, and if raised to 350° it commences to boil. The density of this vapour of mercury is about seven times that of air, and consequently a hundred times that of hydrogen. The volatile nature of mercury is shown by the condensation of drops of the metal on the sides of the glass tube of an ordinary mercurial barometer, in what is known as the Torricellian vacuum, at the top of the column of mercury.

Cinnabar, ore of mercury.

Fusing point of mercury.

Mercuric vapour.

Mercury does not oxidize in either moist or dry air, but when heated to above 300° it slowly absorbs oxygen, and is converted into what is known as the red oxide. On the other hand, mercury combines directly with chlorine, bromine, iodine, and sulphur. This metal is attacked by both sulphuric and nitric acids, but not by hydrochloric acid.

Red oxide of mercury.

One of the most singular properties of mercury is its tendency to combine, at ordinary temperatures, with many of the metals, to form the compounds known as amalgams. If any of our readers wish for an illustration of this action on the part of mercury, let them rub a sovereign with a little mercury for a short time; or leave a ring or other ornament of gold in a small cup of mercury. If a person wearing several gold rings plunges his hand for a few minutes below the surface of liquid mercury, he will find, on withdrawing it, that the rings have become perfectly white. On heating, the mercury in an amalgam is driven off as vapour, and the other metal restored in its original condition. This property of mercury naturally suggests its use in connection with gold mining. The mercury unites with every particle of gold, however small, that exists among the crushed quartz, forming an amalgam from which the precious metal may afterwards be obtained by the simple application of heat. Tin-foil rubbed with mercury forms the amalgam with which the backs of looking-glasses are coated.

Amalgams.

The mercury driven off by heat.

Use of mercury in gold mining.

Coating of looking-glasses.

Mercury, like copper, is a dyad, and forms two classes of salts—the mercurous and the mercuric. The best known of the oxides of mercury is the monoxide or red oxide, HgO, the other being Hg_2O. The reduction of the metallic mercury from the red oxide is a very pretty and striking experiment, that may be performed by any one possessing a test tube and a spirit lamp. Let a small quantity of the red oxide be introduced carefully into a test tube, without touching the sides of the tube, as they should, if possible, be kept quite clean; and, on the application of heat to the bottom of the tube, the oxygen is driven off and the mercury is deposited from its vapour in drops of shining metal on the sides of the tube.

Oxides of mercury.

Reduction of the red oxide.

Mercury forms, with nitric acid, two salts of the class of nitrates—a mercuric and a mercurous nitrate; by far the most important, however, of the compounds of this metal are the chlorides. Mercuric chloride, HgCl, commonly known as corrosive sublimate, is a deadly poison, while mercurous chloride, HgCl, is the substance largely used in medicine, and known as calomel; it behoves the pharmaceutical chemist, therefore, to exercise the utmost care in distinguishing between these two compounds. Corrosive sublimate is soluble in water, which is not the case with calomel; and in its preparation the latter substance is always finely ground and washed, so as to be free from any possible trace of the former. We have already spoken of mercuric sulphide as one of the compounds of mercury which are met with native. It may be prepared artificially by heating a mixture of sulphur and mercury, and forms the valuable pigment known as cinnabar or vermilion. When first precipitated, from the solution of a mercuric salt, the sulphide falls as a black powder, which becomes red and crystalline, however, on sublimation.

Salts of mercury.

Corrosive sublimate and calomel.

Vermilion.

BOTANY.

XXXIII.

The Labiatæ—The Scrofulariaceæ—The Myrtaceæ.

The plants which have their type in the common burnet of the meadows, *Sanguisorba officinalis*, are still more unlike the rose, both in figure and inflorescence; and for practical purposes it is decidedly better that they should be allowed to stand by themselves than be re-

garded as a sub-order of the Rosaceæ. The greater portion are herbaceous; and in most, if not all the species, petals are not developed, or are represented very indifferently. They constitute, nevertheless, a pretty and inviting little group, and in the softness of their simple charms are in several instances unrivalled. Upon all the high grounds in the north of England grows that most dainty little plant, the alpine or silvery Lady's mantle, the fan-lobed leaves of which have a lining of white satin; while everywhere upon the limestone in the southern counties springs up a wild-flower scarcely less pleasing, though in a very different way—the Poterium, so easily recognized by its little tassels of buff-coloured silk.

The great natural order Labiatæ, by Lindley called Lamiaceæ, corresponds with the first section of the fourteenth Linnæan class—"Didynamia Gymnospermia," a few of the genera having only two stamens, being located in the second class, "Diandria." No order is more easily discriminated, the characters being subject to the very smallest degree of variation, and lying within easy and very intelligible compass. The greater portion of the species are herbaceous, though there is a strong tendency, even among some of the minutest — wild thyme, for instance — to form woody and long-enduring stems and branches, clothed with perennial foliage. Now and then, as in rosemary and lavender, the plant becomes decidedly ligneous; and in the tropics there are examples of the attaining of great stature. The leaves are invariably opposite, generally undivided, occasionally pinnatifid, and always devoid of stipules. The calyx is either two-lipped or five-lobed; the corolla is monopetalous, almost always lip-shaped, or "labiate"; the stamens are didynamous, except in the Salvias, Rosemary, and a few others; the ovary is superior, and four-lobed, the lobes separating when ripe, so that we seem to have, what Linnæus called them, four naked seeds. But each of the four is a perfect little one-sceded carpel. Truly "naked seeds" do not occur in any of the orders except the coniferæ and their allies. The inflorescence of the Labiatæ is as a rule quasi-verticillate, the flowers being clustered in the axils of the leaves. Sometimes it becomes paniculate, but of umbels there are no discovered examples. The flowers are of every known colour, and, though small, in their plenty often conspicuous. The leaves are very generally sprinkled with minute globular bags of essential oil, furnishing extremely pretty objects for the microscope; similar bags occur also in the little valleys between the ridges of the calyx, as in the common culinary sage, where they resemble spheres of liquid gold. The plant just named gives a fair idea of the general qualities of the family, when qualities of any positive kind are present. While none of the species are in any degree deleterious, very many are aromatic, as familiarly illustrated not only in sage, but in mint, peppermint, thyme, savory, basil, marjoram, and other "pot-herbs"; also in various species employed in simple medicine—horehound, for instance; and in others again which are esteemed as perfumes, lavender and patchouli standing pre-eminent. Sometimes the odour is so concentrated as to become offensive—a feature of the order exemplified in the common woundwort of the hedgerow, and again in the Ballota nigra. Aroma is by no means universal. Very many of the species are neutral, though contributing, in their cheerful prettiness, to the decoration alike of the woodland and the garden. Geographically, the order is diffused very generally over the temperate latitudes. The maximum number of species appear to belong to the countries bordering upon the Mediterranean, especially those of the northern side, from which have been received all the best and most valued of those kept in gardens, either for ornament or economic use. North America has added the beautiful Monardas. The Perilla and several others came originally from the far East. The primitive form of the many-hued coleus, now so much sought after for the conservatory, is East Indian.

FIG. 182.—SAGE.

The Labiatæ.

FIG. 183.—STRUCTURE OF CRUCIFERÆ.

The plants of this extensive and very interesting order agree, up to a certain point, with the Labiatæ. They are mostly herbaceous; the flowers are monopetalous, very often somewhat lipped, and they usually have didynamous stamens—any departure from this latter rule being in the same direction as that of the incomplete Labiates, namely, to the diandrous state, two of the stamens being abortive. But there is at all times the grand and unmistakable distinction established by the fruit. Instead of a four-lobed ovary, and four seemingly naked

The Scrofulariaceæ.

seeds, here in the Scrofulariads we invariably find a capsule, the seeds contained in which are usually numerous, and very generally beyond the counting. No absolute contrast is furnished by the leaves, for although in most cases alternate, there are plenty of examples of opposite. Neither does the usually square stem of the Labiates serve as a test, seeing that in the genus Scrofularia itself we find it four-angled. The difference in regard to properties is truly remarkable. Not a single instance of aroma, like that of sage or mint, occurs among the Scrofulariads. The musk-plant is powerfully scented, and several others might be named in which odour is very marked, but it is not of the inviting and salubrious kind which gives so much charm to the Labiates. As a rule, on the other hand, the smell of the Scrofulariads, if they yield any, is heavy and repulsive. In conformity with this character, the Scrofulariads very seldom recommend themselves by the gift of anything excellent or desirable, except brightness of blossom. Two or three are esteemed as medicinal agents, one of these being the invaluable foxglove, *Digitalis purpurea*, a poison if taken in over-dose; but not a single species is ever welcome in the kitchen garden, nor are any members of the family resorted to or consumed by quadrupeds. The telling hues and the profusion of the bloom ensure them a place, nevertheless, in our admiration. The flower-garden would seem impoverished were the pentstemon taken away, and old England would lack much of its present beauty were the speedwells to go, and the eyebright, and the yellow toadflax. Although few plants of a shrubby character occur in this family, singular to say it contains a *tree*, so handsome, alike in leaves and flowers, that it has been well named Paulownia *imperialis*. The native country of this wonderful tree is Japan. Hence it thrives fairly well in the south of England, blooming freely when the winter is not so severe as to destroy the buds. The leaves, when full grown, are from nine to twenty inches across. The flowers resemble those of the foxglove, but are of a rich violet purple. As in most other Scrofulariads, the abundant seeds are minute. The Paulownia, in truth, appears to be the tree which, of all others in the world, produces the "smallest of seeds." When our Lord referred to the "mustard tree" as doing this, He probably meant the smallest of seeds yielded by any tree familiar to the crowd He was addressing.

FIG. 184.—SPEEDWELL.

FIG. 185.—STRUCTURE OF LABIATÆ.

In the Myrtaceæ we have one of the truly patrician familes of botanical nature. Invariably ligneous, among them are found the loftiest trees in the world, and innumerable beautiful shrubs, with, at the lowest extreme, some little trailing plants nearly allied to the myrtle *ipsissima*, but though so diminutive, still possessed of woody stems. The leaves are almost invariably opposite, becoming alternate only upon the extremities of the younger twigs. They are always simple and undivided, and filled with translucent oil-glands, so that when held between the eye and the light they appear to be crowded with minute needle-pricks; they are remarkable also, when the lamina is broad enough for the character to be shown, in having the veins near the edge disposed and united in such a way as to constitute an "intramarginal vein," found in no other class of plants. The flowers are regular, very frequently white, sometimes pink or yellow, never blue, pentamerous, with many stamens which are seated upon the calyx, and an inferior, many-seeded ovary. This last, when ripe, becomes either a capsule or some kind of berry. No member of this beautiful family is in the slightest degree deleterious. Many of the species, contrariwise, are renowned for their aroma and the excellence of their products. Essential oils, spices (such as cloves and pimento), and fruits of dainty flavour, are yielded by different species, while others are distinguished by their immense supply of honey. The cheerful and evergreen foliage of various other kinds, and the delicate beauty of the flowers, further recommend the order as one adapted for the decoration of the greenhouse and the conservatory, where it is customary to meet with examples of the elegant plants called Tristania, Melaleuca, and Metrosideros. The common myrtle, famous from the earliest days of literature, is hardy enough to live out of doors in the southern English counties, where it attains, as in Italy and the Holy Land, a stature of many yards. The gigantic trees of the family are Australian, belonging to the genus Eucalyptus, the same which includes the now somewhat popular "Blue-gum" or "Fever-gum" tree, *Eucalyptus globulus*, accredited as a specific, if planted copiously in dangerous neighbourhoods, against the evils arising from malaria. That the tree is useful in this respect, there can be no doubt: the point would seem to be not to attach too great a value to it. Unfortunately it is just too tender

The Myrtaceæ.

to live in the open air permanently in England. It will endure for several years, but succumbs before frosts of unusual severity. None of the Myrtaceæ are European. The greater portion of the order is tropical; very many of the species are confined to Australia and the neighbouring islands.

NATURALNESS AND AFFECTATION.

BY THOMAS DUNMAN.

ONE of the sorest temptations to which the youth of the present age is subject is that of attempting to exhibit himself to the world as a much more favourable specimen of humanity than he feels himself to be. In every walk of life there is a great tendency to that which is known as "affectation," few individuals of either sex being satisfied with presenting themselves to the world *as they are*.

In estimating the value of a practice, two things have to be considered—Is it right? and does it pay? To both of these questions in the case of affectation a most emphatic negative must be the answer. To endeavour to persuade the world that you are wiser or richer or better than you really are, is to be guilty of a false pretence; and it is perfectly certain that a very large majority of mankind are far too shrewd not to readily see through the thin veneering of affectation beneath which you endeavour to disguise yourself, and the result of their scrutiny is contempt rather than admiration.

The besetting sin of the present age, especially in the middle classes, is what is known as "keeping up an appearance," and a very ugly and unprofitable sin it is. It is a by no means favourable sign of the times that poverty is so generally looked upon as a crime, and that so many people, who in other respects are worthy members of society, are willing to stoop to almost any meanness rather than be thought poor. Mrs. Brown, whose husband is in the receipt of a comfortable income, sets up a servant; whereupon Mrs. Jones, who lives opposite, and who is blessed with a large family for whom she can by a little pinching just manage to find food and clothing, immediately does the same; not that she wants a servant, but because she must keep up appearances, or she will be thought nothing of,—at least so she, in strict confidence, informs Mrs. Robinson, her bosom friend. Then, again, young Smith, who is a junior clerk with a somewhat slender salary, copies in every respect the articled clerk whose father is in the position to afford his son a very liberal amount of pocket-money, and whose career is cut out for him. The result of these irrational proceedings is, in both cases, debt, with all its attendant anxieties, if not worse. Yet how many young people of both sexes we find with these absurd and ruinous ideas, and yet who wonder that they do not make way in life! Our actual wants are very largely dependent on our desires; and if we carefully avoid the endeavour to persuade the world that we are richer than we really are, it will save a very large amount of unhappiness, and greatly increase the respect which we inspire in others. Those whom we think most dazzled by our attempt to keep up a good appearance are frequently those who laugh most heartily at us, and see most readily through our ridiculous attempts at display.

Few people are entirely free from affectation in the matter of dress and deportment. The present æsthetic movement, absurd as it undoubtedly is when carried to extremes, had its origin in a protest against the gaudy and meretricious style of dress and ornamentation which so many think fit to adopt. To dress well does not, in the eyes of some people, signify to clothe the person in good and tasteful materials suitable to the position of the wearer, but to put on cheap imitations of the more costly apparel worn by those of a superior grade in society. Those who cannot afford real jewellery are not sufficiently honest and self-respecting to do without it altogether, but adorn themselves with cheap imitations, under the delusion that they will be mistaken for the genuine article.

Affectation in dress is usually accompanied by an affected and unnatural deportment. The wearers of rings, whether real or imitation, are far too apt to place the hands in such a position as to show them off to the best advantage, and other articles of jewellery are frequently thrust upon public notice in an equally obtrusive manner. The effect of these artifices upon spectators is always the reverse of what is desired; and even if it were not, such practices are utterly unworthy of those who desire to possess self-respect. Those who place such a high value upon outside adornment are usually very deficient in that inner adornment of the mind which alone makes the true man or woman. The words of the Ayrshire ploughman should ring with ever-increasing clearness in our ears:—

> "What though on homely fare we dine,
> Wear hodden grey and a' that,
> Gie fools their silk and knaves their wine,
> We dare be poor for a' that."

To be genuine and unaffected—to be *ourselves*—is a surer way to gain the respect of others than any affectation, however studied, or any artifice, however skilful.

An affectation which is very irritating, and by no means uncommon, is that of learning. This is a sure sign of the individual who possesses that little knowledge which is such a dangerous thing. Such a person is constantly endeavouring to "show off" before company. If an opportunity occur, he will enlarge upon the derivation of some technical term, or will endeavour to explain some recondite fact in art and science, constantly interlarding his conversation with "words of learned length and thundering sound," of some of which he barely knows the meaning. Such affectation is a proof of ill-breeding and want

of taste, and is seldom, if ever, successful in inspiring respect. Akin to this assumption of superior knowledge is the common affectation of a precise or mincing manner of speaking. This is the certain mark of a superabundance of self-conceit, and has a very irritating effect upon listeners. Many a pleasant and musical voice is spoilt by the very affected manner of using it. Few people sing in a perfectly natural manner, and it frequently happens that this is so with persons who in other respects are the reverse of affected. Nevertheless it is a very disagreeable practice to adopt any affectation in singing, and should be carefully guarded against, as it often mars what in every other respect is a very creditable performance.

One of the most irritating forms of affectation is frequently seen in the art of writing. More ill-temper and annoyance are caused by bad writing than some would readily believe, and though this is in many cases the result of carelessness, it is frequently the result of affectation. Many people, and especially young people, seem to think there is something very fine in adopting a style of handwriting different from that of ordinary individuals, and the result is a scrawl which is barely intelligible, if at all. The signature is rarely legibly written, many priding themselves on the intricacy of its dashes, strokes, and curves. This practice of disguising the signature, often the most important part of a letter, is a mark either of gross carelessness, ignorance, or affectation, and should be carefully guarded against. Only a few here and there can write supremely well, but all may and ought to write legibly, as no one has the right to unnecessarily waste the time and patience of other people.

A very serious and reprehensible form of affectation is that which may be denominated as "Byronism." Happily this practice has of late years largely decreased, but it may still, in some form or other, be occasionally found. It consists in the pretending to be of a much worse character than is really the case, sometimes with the object of drawing compliments from others, but occasionally for the express purpose of causing consternation and alarm in the breasts of homely and sedate people. The young man who professes, with a considerable amount of bluster, opinions dangerously approaching infidelity or atheism, merely for the purpose of shocking propriety, is a most unattractive specimen of the genus *homo*; and still more objectionable is the young lady who affects to be "fast," and who talks freely upon subjects of which she should know nothing. When affectation reaches such lengths as these, it approaches very nearly the boundary which separates mere folly from sin.

A common form of affectation is that of extreme importance; and this is a phase in which the failing frequently appears among young people of both sexes when far from home. How often at an hotel table you hear people boasting about the style in which they are accustomed to live when at home, and comparing the accommodation of the hotel with that of their own house, always to the great disadvantage of the former. Many individuals seem to find it impossible to enter into conversation without constantly turning it towards themselves, never allowing the least opportunity to escape of obtruding themselves upon the notice of the company. If such persons were to calmly consider the effect which such a course of proceeding has upon those around them, they would assuredly abstain altogether from it.

Strange as it may seem, the various phases of affectation have their source in a want of self-esteem. The very practice of affected manners is a *primâ-facie* proof that the individuals who indulge in it are afraid that if they were to appear in their natural colours they would fail to gain respect. If this be really so, then it is an argument for the improvement of self, and not for the putting on of affected manners, for these lower and do not raise the moral character, and are moreover quite incapable of imposing upon any but the very few. Honest mediocrity may, and generally does, command respect, but the attempt to lacquer it over with a superficial coating of affectation will sooner or later end in supreme contempt. The key-note for those who desire the esteem of others, as well as of themselves, is B natural. Honesty in this, as in every other respect, is the best policy.

ZOOLOGY.

VII.

Man-like Monkeys—The Gorilla (*continued*).

Let us now examine the structure of the gorilla, and see how closely he may be compared with man. From the outside we are at once struck with the great size of the face, its forward projection, the strong overhanging eyebrows, and the low retreating forehead. The limbs are evidently contrasted in their proportions, the upper being much the longer, and much stouter relatively than man's; the lower limbs are short and thickset. **Structure of gorilla.**

The height of the skeleton is from five feet to five feet eight inches, but in the wild state the elevation of the head is much less than this, in consequence of the bending of the thigh on the trunk and lower leg, and the trunk being inclined forwards. It is questionable if the gorilla ever or at all frequently walks quite erect. The females do not appear to reach a greater length than four feet and a half. **Height and posture.**

The greater part of the body is covered with very black hair or fur, but on the head it is reddish brown. The strong overhanging brows give the eyes a sunken appearance: a characteristic human feature is lost by the hair of the eyebrows being continuous with that on the forehead. The ears very much resemble those **Characters of head.**

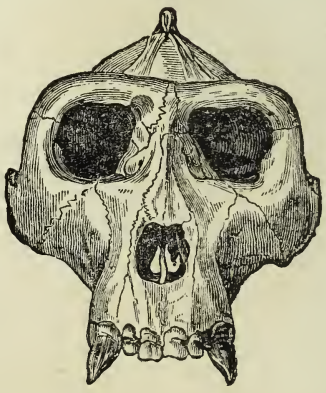
of man even in their small curves. The nose is broad, thick, and flat, somewhat projecting. The muzzle juts forward in a very grim way, being much rounded. The lips are little thickened at their edges, and have no specially red outer portion. The lips are easily drawn back from the teeth, which extend somewhat forwards, and the large size and conical shape of the canines give an undoubtedly fierce aspect to the gape. The chin is low, and not covered with any special beard.

An adult gorilla's skull presents a very different aspect from that of man. Instead of being horizontally extended, with the length much greater than the height, the lower type of skull is much higher than long, and stretches high up behind in strong massive ridges. Indeed, these latter are the most prominent features of the skull, while in man it is the rounded outline of the brain-case that is most striking. The brain-case in the gorilla is quite a subordinate element in the general aspect of the skull, and its actual internal capacity is less than one-half that of the lowest known type of man. The average European has a brain-case capable of holding nearly five pints of fluid; the gorilla's will contain but a pint and a half.

The adult skull.

All are familiar with the bony ridge on the side of the human face below the temples and in front of the ear. Above this is a space free of bone, and occupied by soft muscle, which is a great means of raising the jaw in chewing; the space is called the temporal pit, the muscle the temporal muscle. In the gorilla the pit and muscle are of huge relative size, occupying the greater portion of the side and crown of the head. The boundaries of the space are strong and elevated ridges all round, and this is one indication that the creature wields his jaws with a force and energy very far superior to that of any specimen of humanity. The upper and back part of the lower jaw is similarly broad and massive.

The pit for the temporal muscle.



SKULL OF MALE GORILLA.

The great ridges do not add to the weight of the skull so much as might be imagined. Very great use is made in the structure of bones, of the arch-form, in which the greatest amount of strength is secured with the least employment of material. While the surface of the bone is very dense and compact, underneath it is composed of very open work, of slender but strong interlacing pillars and arches. Female and young gorillas do not possess these ridges in anything like so great proportions as the full-grown males.

Structure of skull-bones.

The brain of the gorilla is smaller than man's, just as the brain-case is; yet in shape and in all the broad features of their organisation they are similar. There are, on the whole, just the same surface markings and grooves; but the cerebral hemispheres in the gorilla are flatter, less convex than in man, and taper off more in front.

Brain.

The teeth of the gorilla are much more prominent elements in his features than the corresponding implements in man. His lips, being less fleshy, easily show the front and the eye-teeth in both jaws. The front teeth, or incisors, project a little forwards in the upper jaw, overlapping the lower when the mouth is closed. They are chisel-shaped at the top, like man's, but have a stronger base. It appears that they gradually wear down, and it is suggested that this is due to gripping branches with the teeth in the process of breaking them down to get at the fruit.

Teeth.

Incisors.

Outside the incisors in the upper jaw is the space into which the lower canine or eye-tooth fits, then comes the great upper canine, which fits behind the lower into a corresponding space. These canines are very strong and massive at the base, and sharp-pointed and conical at the apex, being much larger and stronger than those of man. The old male gorilla is distinguished for the size of his canines, which look formidable weapons, and give him a ferocious aspect.

Canines.

The hinder or grinding teeth are in two straight parallel rows in each jaw, the rows not being separated by so wide a space as in the human jaws, and contrasting with the curve which man's rows of teeth exhibit. Their crowns or grinding surfaces are squares with the angles rounded off, and are rough and irregular, with a number of knobs or blunt projections, which fit them admirably for crushing and chewing.

Molars.

As regards the organization of the trunk, we may notice that the gorilla's head is set on the spinal column somewhat backwards, so that its natural position is not quite erect. Consequently, as the gorilla, living amongst trees, and often going on all-fours, has to look very much forwards and upwards, the ligaments or fibrous cords uniting the bones and the muscles of the neck are stronger than in man. This structure enables the head to be well pulled back and raised, and thus the neck can sustain the weight which otherwise would be thrown forwards.

Skull-joint with backbone.

In examining a gorilla's skeleton, we see the cause of its short-necked appearance partly in the size and low position of the lower jaw, and partly in the elevated situation and size of the blade-bone or scapula, and the collar-bone or clavicle. These latter are large and strong. The neck consequently looks thick and stumpy, and the back is very rounded and ungraceful. The gorilla, however, is amply compensated by

Trunk.

Neck and back.

the power in climbing which he obtains by the strength of these bones; for the size and stoutness of bones is very much in correspondence to the strength of the muscles attached to them; and the use of the shoulders in climbing is evident to us in our own youthful adventures.

Chest.

An anatomist looking at the gorilla's chest sees at once the advantages he must have in breathing, so as to be capable of great spurts of exertion. Instead of a nearly cylindrical bony cavity, as in man, the gorilla has a conical one with a wide base, so that the lower part of the chest is very broad. The extra pair of ribs, making thirteen pairs in all, gives an important addition, in size, strength, and means of attachment of muscles for the opening and contraction of the chest in breathing. Thus, the gorilla is enabled to take in half as much air again as man into his lungs —an enormous advantage in endurance. The breast-bone, too, is larger, flatter, and stouter than in man, less liable to injury from an attack in front. The heart is large, but there are no conspicuous differences in its structure or the branching of the blood-vessels.

Advantages for breathing.

The abdomen of the gorilla is large, and contains bulky organs. As he lives chiefly on vegetable food, which is less nutritious in proportion to its bulk than flesh, he requires and has a large stomach. Not only vegetable fruits such as bananas, but also leaves of pineapples and palms, the pith of sugar-canes and of juicy plants generally, are included in the gorilla's favourite dietary.

Adaptation for vegetable food.

WANDEROO MONKEY.

The abdomen is supported upon large and strong haunch-bones. These are tall and expanded, much more so than in man, although the general outline is the same. The hip-bones, upon which the animal rests in sitting, are very strong and broadly extended; but in size and relative position the bones and muscles are comparatively little adapted to the erect posture, which anatomists, on this evidence, deny to be habitual.

Haunches.

In the upper limbs of the gorilla, the things most prominently forced upon our attention are their stoutness and deficiency in symmetry and elegance, their great proportionate length, and the adaptation of the "hands" for use in walking, resting, and climbing. The great bone of the arm, or humerus, is stouter and less curved than in man, but resembles ours in being larger than the bones of the fore-arm. The latter, or radius and ulna, are specially noticeable for the increased arch between them, bowing out the limb, and giving more leverage for the muscles by which the wrist is turned outwards or inwards. The most habitual position of the palm, however, is like that which ours assumes when hanging loose at the side — namely, looking directly inwards, with the thumb forwards.

Upper limbs.

The gorilla's hand is one-third longer than man's, the palm-bones, or metacarpals, and the first joints of the fingers being especially lengthened. But as the hand is supplied with larger muscles than ours, and with a very hairy skin on the back, it looks the reverse of slender and long, rather stout and stumpy, and this is more impressed upon us because the skin between the bases of the fingers reaches nearly to their second joint.

Hand.

Another important circumstance has relation to the comparatively short thumb, which in the skeleton makes a greater angle with the other digits than in us, and so stands out more. For all that, it is not more really a thumb—it is in some respects even less thumblike than ours; for, in common with the other great apes, it lacks one muscle which extends the first joint of the thumb. It is rather developed for great power in grasping, and widening the base of support for the limb, than for complex and finely graduated movements. The gorilla's hand has an advantage in another respect, in possessing a special muscle which pulls the fifth digit apart from the fourth, thus again widening the surface of the hand for grasping.

Thumb.

The wrist is short and strong, as it transmits a considerable weight to the hand in walking on all-fours. This is supported by the joints of the fingers being bent and resting upon the ground. To receive this weight the fibrous tissue and the skin on the back of the last two joints of the fingers are thickened and made into strong supporting pads. In climbing, the gorilla does not naturally place his palms towards him, as we should do very often, but has his knuckles facing him, and the palm on the other side.

Wrist.

Pads on knuckles.

Climbing is a matter very much depending on the arms and shoulders, by the muscles of which the whole body has to be raised. It is found that this expert climber has no new muscles or bones to facilitate his climbing, only those common to him and to man, made larger and stronger when necessary. The great deltoid muscle, forming the prominence of the shoulder in front, the biceps clothing the front of the upper arm, and the triceps on its back, are large and long, being bulky where they are

Climbing.

attached to the bones, as well as in the middle; thus symmetry is lost, but power is gained.

In the lower limbs we notice that the bones are shorter, stouter and less curved than in man, that the feet are shorter than ours, and the great toe projects inwards to the middle line most remarkably, much more than the thumb does. This gives the foot a most curious outside appearance. The use of this toe-thumb is very great in clinging round branches of trees. It is on the bones of the outer edge of the foot that the gorilla rests most of his weight when walking; thus the sole of the foot, which is almost destitute of hair, and very sensitive for use in climbing, is continually turned inwards.

Lower limbs.

Toes.

Every bone of the gorilla's foot is the same in general form and relative position as in man; yet as they appear in the skeleton they present great contrasts—the human shapely, the non-human unshapely and ungraceful. Although the great toe is almost as freely movable as a thumb, yet this does not constitute the foot a hand. The essential peculiarities of structure which make the human lower member a foot are present in the gorilla. The foot is most especially constructed for bearing the weight of the body, the hand for free movement.

Foot.

The gorilla's ankle is stout and thick, as the great tendon at the back of it (Achilles' tendon) is covered with muscular fibres quite low down, instead of being without them for some distance, as in us. The calf is less prominent and bulky than in many a man; the gorilla does not get trained by walking-matches. His thigh-bone (femur) is stout and nearly straight, shorter indeed than the arm-bone or humerus. Even from the ridges and markings on the back of it we can see that the gorilla is not highly adapted for the upright posture; for these markings always correspond to the strength of the muscles attached. But these ridges are strong and well marked in very old races of mankind, showing no sign of transition between the erect posture of humanity and the inclined or the all-fours attitude of the gorilla.

Calf.

Thigh.

Lastly, as to the voice of the gorilla, and the agency for producing it. No one now attributes articulate speech to this species, and any anatomist would say that it was impossible. We learn from Dr. Savage that the loud sound emitted by the male sounds like 'kh-ah, kh-ah.' The voice-organ by itself shows a great deficiency in those nicely adapted arrangements so conspicuous in the human species. But the gorilla has, on the contrary, a capital organ for making the sounds he produces resound far and wide; for his larynx, or voice-organ, communicates in front with a big air-sac, which can be dilated at pleasure, so as to make a projection all over the front of the neck.

Voice and air-sac.

What shall we say, then, of the gorilla? Manlike he certainly is in many points of structure, so far as relative position and animal function are concerned. But as in machinery a little bit of delicate adaptation often infinitely increases the power of the whole, so man, considered even as an animal, is indefinitely higher than the gorilla, by reason of a multitude of finer arrangements of parts. An anatomist who only knew the structure of lower animals could not fail to see, when he came to dissect the human body, that this is a creature of far greater capabilities. Of intelligence we perceive comparatively little in the gorilla. It is when he is young that he is nearest to humanity, as of necessity there are many similar things to be learnt by the babies of all the higher species. We can afford to acknowledge to the full all the resemblances between man and the gorilla. Man is naturally far higher.

XXXII.

THE VERB (*continued*).

§ 202. *Auxiliaries*:—1. Be; 2. Have; 3. Will; 4. Shall; 5. Can; 6. May; 7. Do; 8. Dare; 9. Owe; 10. Must; 11. Let.
§ 203. Some defective verbs.

§ 202. **Auxiliary** and **Defective** Verbs.—The auxiliaries, as we have now seen, serve three purposes as helps to other verbs in English:—

1. To form the Passive voice—*Be.*
2. Auxiliaries of Tense or time—*Have, will, shall, be.*
3. Auxiliaries of Mood—*Can, may, must, do, should, durst, ought.*

But some of these are also independent verbs; they then bear a different shade of meaning, and are in a few cases inflected differently.

1. TO BE.

INFINITIVE. **Be.**

Verbal Noun and Present Participle, **being.**
Past Participle, **been.**

INDICATIVE—*Present.*

Singular.	*Plural.*
I **am**	we **are**
thou **art**	you **are**
he **is**	they **are.**

Past.

I **was**	we **were**
thou **wast**	you **were**
he **was**	they **were.**

Future.

I **shall be**	we **shall be**
thou **shalt be**	you **shall be**
he **shall be**	they **shall be.**

SUBJUNCTIVE—*Present.*

if I **be**	if we **be**
if thou **be**	if you **be**
if he **be**	if they **be.**

Past.

if I **were**	if we **were**
if thou **wert**	if you **were**
if he **were**	if they **were.**

IMPERATIVE MOOD.

be thou	**be** you.

Be is the auxiliary of time, by which all the *continuous* tenses of other verbs are formed; from its nature we cannot make continuous tenses for itself; the perfect tenses are formed by the aid of *have: Pres. perf.* I **have been**, *past perf.* I **had been**, etc.

The conjugation of *be* includes *be, as, was*, parts of three old verbs, probably coming from several old dialects which went to compose the earliest English itself a fourth, *sind* = *are*, used till the thirteenth century, is now lost. The oldest English had:—

Pres. Indic.	*S.* 1.	eom, beom, beo.
	2.	eart, bist.
	3.	is, bith.
	P. 1, 2, 3.	sind, sindon, beoth, aron.
Past Indic.	*S.* 1.	wæs.
	2.	wære.
	3	wæs.
	P. 1, 2, 3.	wæron.
Pres. Subj.	*S.* 1, 2, 3.	wese, beo, si.
	P. 1, 2, 3.	wesen, beon, sin.

In some Elizabethan writers, and as late as Milton's time—even now in some country districts—*be* was and is used in the present tense:—

S. 1. I be	*P.* we be, bin, ben
2. thou beest	ye be
3. he be	they be, ben.

2. To Have.

INFINITIVE. **Have.**

Verbal Noun and Present Participle, **having.** *Passive Participle*, **had.**

INDICATIVE—*Present.*

Singular.	*Plural.*
I **have**	we **have**
thou **hast**	you **have**
he **has**	they **have.**

Past.

I **had**	we **had**
thou **hadst**	you **had**
he **had**	they **had.**

Future.

I **shall have**	we **shall have**
thou **shalt have**	you **shall have**
he **shall have**	they **shall have.**

SUBJUNCTIVE—*Present.*

if I **have**	if we **have**
if thou **have**	if you **have**
if he **have**	if they **have.**

Past.

if I **had**	if we **had**
if thou **hadst**	if you **had**
if he **had**	if they **had.**

IMPERATIVE.

have thou	**have** you.

Have in the sense of *possess, keep*, is an active verb, and can be conjugated in all tenses and as a passive. The verb is regular, but some parts are contracted, as—

hast from *havest, hav'st*
hath „ *haveth, hav'th*
has „ *haves, hav's*
had „ *haved, hav'd.*

3. Will.

INDICATIVE—*Present.*

Singular.	*Plural.*
I **will**	we **will**
thou **wilt**	you **will**
he **will**	they **will.**

Past.

I **would**	we **would**
thou **wouldst**	you **would**
he **would**	they **would.**

As an Auxiliary, *will* goes to form the future indicative of other verbs; *would* loses its sense of past time, and goes to form one of the present tenses of the subjunctive (conditional form—see § 199).

As an independent verb, signifying *volition* or *desire, will* is declined like a regular weak verb: *Present*—I will, thou will*est* or wil*t*, he will*s*, etc.; *past*—I willed, etc.

Won't is a contraction of *wol not, wol* being the form of *will* in middle English.

4. Shall.

INDICATIVE—*Present.*

Singular.	*Plural.*
I **shall**	we **shall**
thou **shalt**	you **shall**
he **shall**	they **shall.**

Past.

I **should**	we **should**
thou **shouldst**	you **should**
he **should**	they **should.**

Shall has no infinitive. In the first person it is auxiliary of future time; in the second and third persons it is used in the sense of *ought* or *must*, as *should* is also sometimes used; in those cases it is an independent verb. (The first person, "I shall," has lost this sense which it formerly bore.)

Ex. *Auxiliary:*—

"I shall go to town." "We shall be there."

"You shall go to bed"—*i.e.* you must go to bed.

"They shall be at home to meet you"—*i.e.* they *ought*, with a sense of certainty.

Should, though an old past, is used to make a present subjunctive in the *first persons* (conditional form): "I should like a fortune;" "we should take a house." *Should* in all the persons will convey the sense of *ought*—as, "we should be rich;" "I should be great."

5. Can.

INDICATIVE—*Present.*

Singular.	*Plural.*
I **can**	we **can**
thou **canst**	you **can**
he **can**	they **can.**

Past.

I **could**	we **could**
thou **couldst**	you **could**
he **could**	they **could.**

Can gives the sense of *power, being able* (compare the German *können*, to be able), and is therefore used as an auxiliary of mood (the present form having a more certain ring than the past—"I *ean* make a cake;" "I *could* be

happy "), not of time. It has now no infinitive or other parts.

The old verb had *cuthe* as its past tense; the *l* in *could* is a mistake in the endeavour to make the past of *can* on the same mould as *should* and *would*.

6. May.

INDICATIVE—*Present.*

Singular.	*Plural.*
I **may**	we **may**
thou **mayest**	you **may**
he **may**	they **may**

Past.

I **might**	we **might**
thou **mightest**	you **might**
he **might**	they **might**

May bears the sense in a few instances of *can*—"I will do what I *may* towards your release;" but it usually expresses *permission*—

"She may nurse her doll,"
"They might have their books."

It is also defective. Like *can*, it may be considered as an auxiliary of mood. Dr. Morris, however, parses *can*, *may*, etc., as independent verbs.

7. To Do.

INFINITIVE. **Do.**

Verbal Noun and Present Participle, **doing.**
Past Participle, **done.**

INDICATIVE—*Present.*

Singular.	*Plural.*
I **do**	we **do**
thou **dost, doest**	you **do**
he **does, doth**	they **do.**

Past.

I **did**	we **did**
thou **didst**	you **did**
he **did**	they **did.**

Do, as an independent verb, can be conjugated in all moods and tenses. As an auxiliary, the present and past indicative give emphasis: "I *do* declare!" "he *did* run fast!" It is also used in negative and interrogative sentences, a peculiarly English idiom —"I do not think so;" "do you take coffee?" "I did not find him at home."

8. To Dare.

INFINITIVE. **Dare.**

Verbal Noun and Present Participle, **daring.**
Past Participle, **dared.**

INDICATIVE—*Present.*

Singular.	*Plural.*
I **dare**	we **dare**
thou **darest**	you **dare**
he **dares**	they **dare.**

Past.

I **durst**	we **durst**
thou **durst**	you **durst**
he **durst**	they **durst.**

Dare as an active verb, meaning to *challenge*, is conjugated like a weak verb—"he dared me to do it." As an auxiliary of mood it signifies to *venture*: "you dare not tell her;" "she durst not face the sea."

9. To Owe.

INDICATIVE—*Present.*

Singular.	*Plural.*
I **owe**	we **owe**
thou **owest**	you **owe**
he **owes**	they **owe.**

Past.

I **ought**	we **ought**
thou **oughtest**	you **ought**
he **ought**	they **ought.**

When *owe* means *to be in debt*, it is conjugated like a regular weak verb—"I owed him a sum of money;" "this was owing to me;" "she had owed him her life." As an auxiliary of mood, the past *ought* is used, meaning duty, with, however, a present sense. It is the only auxiliary that takes *to* before the infinitive: "I ought to tell you;" "she ought to have been careful."

Owe formerly signified *own, possess.* Thus we find the lines—

"Nor board nor garner *owe* we now,
Nor roof nor latchèd door."
Chough and Crow, in Scott's "Guy Mannering."

10. **Must** has now no other parts; it is used for all persons, with a present sense of obligation. If we wish to express the same idea in past time, we use the phrase *was* or *were obliged*: "I must take physic," "I was obliged to take physic."

The old English had a verb *môt*—
Pres. indic. *môt*, meaning *may, can.*
Past indic. *môste* ,, *might, could.*
Our *must* is a relic of this *môste.*

11. **Let** is a strong verb, only used as an auxiliary verb in the sense of *allow* or *permit*; in the imperative for the first and third persons of other verbs, the infinitive without *to* following it: "Let me go here," "let them play music."

§ 203. **Defective** Verbs.—A few peculiar words should not be passed over, such as *wit, worth, hight, dight.*

Wit—Infinitive, *to wit*; pres. indic., *I wot*; past indic., *I wist.* An old verb meaning *to know, to be aware*, whence we have also now the adverb *wittingly.*

"As for this Moses, we *wot* not what is become of him."—Exod. xxxii. 1.
"Moses *wist* not that his face shone."—Exod. xxxiv. 29.

Worth, used in the subjunctive; part of an old verb *weordan*, to become, or to be-to (compare German *werden*). "Woe worth the day" (Ezek. xxx. 2).

"Wel *wurth* suffraunce yat abatez strif,
Wo *wurth* hastinesce yat reves man his lif."
Old Saying, in MS. Gray's Inn 12, *fol.* 19.

Hight and *dight* are the past forms of two old verbs—*hâtan*, to be named, past *hight*; *dihtan*, to make ready, dress, past part. *dight.*

"This grisly beast which Lion *hight* by name."
Mids. Night's Dream, Act v., sc. 1.

"The clouds in thousand liveries *dight*."
MILTON, *L'Allegro*, l. 62.

"So dolefully as he was *dight*."
York Play, 15th cent.

Impersonal verbs are inflected for their parts, which are as follows :—

Infinitive	to **rain**	to **freeze.**
Indic. pres., 3rd pers. sing.	it **rains**	it **freezes.**
Indic. past, 3rd pers. sing.	it **rained**	it **froze.**
Indic. future	it **will rain** or	**freeze**

The verb **need** may be used in an impersonal, as well as in an active sense.

XXXIV.

NUMERAL ADJECTIVES (*continued*).

VOCABULARY.

die Inſel,[1] the island
dee in'-zel

entdecken[2] (imp. entdeckte, p. part. entdeckt), to discover
ent-deck'-en ent-deckte

gewinnen (imp. gewann, p. part. gewonnen), to win
ge-vin'-nen ge-vann' ge-von'-nen

liefern (imp. lieferte, p. part. geliefert), to deliver
lee'-fern lee'-ferr-te

die Unſterblichkeit,[3] immortality
dee un-stairr'-blich-kite

die Krankheit, the illness
dee krank'-hite

der Redner, the orator
dare rayd'-nerr

der Enkel, the grandson
dare en'-kel

unglücklich, unhappy
un-glueck'-lich

der Kerker,[4] the prison
dare kayrr'-kerr

umgebracht, killed, murdered
um'-ge-bracht

beſteigen[6] (imp. beſtieg, p. part. beſtiegen), to mount, ascend
be-sty'-gen be-steech' be-stee'-gen

die Wittwe, the widow
dee vitt'-ve

die Regierung,[7] the government, rule, reign
dee ray-gee'-rung

dauern (imp. dauerte, p. part. gedauert), to last, endure
dow'-ern dow'-er'-te ge-dow'-ert

ſchier,[8] full, complete, pure
sheerr

das Lied, the song
dass leed

der Krieger, the warrior
dare kree'gerr

Mann[9] (plur.), men (soldiers)
mann

das Linienſchiff, the ship of the line
dass leen'-yen-shiff

die Mannſchaft, the crew
dee mann'-shafft

die Kanone, the cannon
dee kah-no'-ne

aufbieten[10] (imp. ich bot auf, p.p. aufgeboten), to muster
owff'-bee-ten ich boat owff owff-ge-bo-ten

wiſſenſchaftlich,[11] scientific
vis'-sen-shafft'-lich

die Laufbahn,[12] the career
dee lowff-bahn

erſtrecken, to extend
er-streck'-en

Fortſetzen (imp. Ich ſetzte fort, p. part. fortgeſetzt), to continue
forrt'-zet-sen ich zets'-te forrt forrt'-ge-zetst

ungefähr, about (approximately)
un'-ge-fairr

der Einwohner,[13] the inhabitant
dare ine'-voh-ner

der Prätendent, the pretender
dare pray-ten-dent

der Roth-bart, the red-beard (*barbarossa*)
dare rote'-bahrt

die Aus-ſage, the declaration or testimony
dee owss'-zah-ge

ſchmachten (imp. ſchmachtete, p. part. geſchmachtet), to languish
shmach'-ten shmach'-te-te ge-shmach'-tet

die Gefangenſchaft,[14] imprisonment
dee ge-fang'-en-shaft

verſchieden,[15] different
fer-sheed'-en

OBSERVATIONS.

[1] (Notice that no equivalent for the English *of* and the French *de* (the city *of* Rochester, la ville *de* Paris, the Republic *of* Venice, etc.) is placed in German with names of countries, provinces, islands, towns, etc.: *die Stadt Rochester, die Republik Venedig,* dee statt Rochester dee Ray-poo-bleek Vay-nay'-dich *die Insel Tahiti,* dee in'-zel Ta-hee'-tee

[2] From *decken*, to cover, and the prefix *ent*, meaning here *un* or *de*—as in *entvolkern*, to depopulate; *entkleiden*, to disclothe or divest. dek'-ken ent-foelk'-errn ent-kly'-den

[3] From *sterblich*, mortal, with the negative prefix *un*, and the termination *keit*, equivalent to *hood* or *ness*. stairb'-lich

[4] *Kerker* is derived from the Latin *carcer*; hence the verb *einkerkern*, to incarcerate.. kayrr'-kerr ine'-kairr-kern

[5] *Um etwas bringen* means to deprive of anything: *er hat ihn um sein Geld gebracht*, he had deprived him of his money. Thus *umbringen* (without an object) is to deprive a man of his greatest possession, his life. um et'-wass bring'-en err hat een um zine gelt ge-bracht'

[6] The prefix *be* makes this verb transitive (*i.e.* shows that it has an object). *Steigen* is to mount, generally: *ein Pferd besteigen*, to mount a horse. sty'-gen ine pfairrd be-sty'-gen

[7] The verb *regieren* is from the Latin *regere*, to rule. re-geer'-en

[8] The English word "sheer" is from *schier*—as sheerr
sheer forgotten; sheer deception.

[9] The form *Mann* is used for the plural in speaking of a military force. The literal plural is *Männer*.

[10] *Aufbieten*, literally to bid up or offer: *das Auf-* owff'-bee-ten dass owff'-
gebot, the levy of troops.
ge-bote

[11] *Die Wissenschaft*, science—from *wissen*, to know dee vis'-sen-shafft vis'-sen
(*scire*); *die Kunst*, art, from *können*, to be able.

[12] From *laufen*, to run, and *die Bahn*, the way. lowff'-en
Hence *Eisenbahn*, iron road or railway.

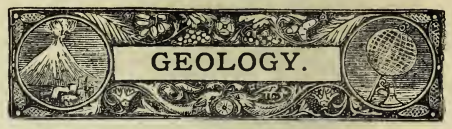
[13] *Der Einwohner*, from *ein*, in, and *wohnen*, to dwell—dare ine'-voh-ner
the indweller.

[14] *Die Gefangenschaft*, from *fangen*, to catch, and the dee ge-fang'-en-shafft fang'-en
termination *schaft*, ship.

[15] *Verschieden*, from the verb *scheiden* (imp. *schied*, fer-shee'-den shy'-den sheed
p. part. *geschieden*), to sever or part.
ge-sheed'-en

English Version, for Correcting and Re-translating the Foregoing Study.

The town (of) Brighton is fifty English miles from London. In the year 1492 the West India Islands were discovered by Christopher Columbus. Napoleon won the great battles of (bei) Austerlitz and of Jena. They were fought (geliefert) in the years 1805 and 1806. "Twenty years," says Schiller's Don Carlos, "and nothing done for immortality." On the 2nd (of) April, in the year 1791, died, after a short illness, the great orator Mirabeau. Richard II., king of England, was the grandson of Edward III. After the unhappy emperor Peter III. had been murdered in prison, his widow, Catharine II., ascended the Russian throne. Her rule lasted till the year 1796. "Full thirty years art thou old," says in the song the old warrior to his cloak. Fourteen thousand men were sent by the French to Egypt in the year 1798. In the great naval battle of Aboukir, on the 1st of August in the same year, the English, as also the French, had thirteen ships of the line. The latter (these) had, however, eleven hundred and ninety-six cannon, and a force of eleven thousand two hundred and thirty souls; while the former (those) could muster only a thousand and twelve cannon, and eight thousand and sixty-eight men. Ninety years old, after a scientific career that extended over more than sixty years, died Alexander von Humboldt, in 1859. Under Henry VIII. the Reformation in England began; under Edward VI. it was continued. The great and beautiful capital Dresden has about a hundred and seventy-seven thousand inhabitants. Charles Edward, called the young Pretender, was the grandson of James II.; he died on the 30th January, 1788, in Rome. After (upon) Frederick I., called the Redbeard, followed, in the year 1190, his son Henry VI., who already after seven years died. Nineteen years long the young king James I. of Scotland languished in English captivity. I have told it to thee, that it may not be forgotten. The declarations of two men are sometimes different.



XXVII.

CHARACTERISTIC BRITISH FOSSILS.

POST-PLIOCENE.

Mammalia—Palæolithic man, lion, lynx, glutton, otter, mammoth, hippopotamus, rhinoceros (two species), beaver, Irish elk, red deer, bison, musk ox, Bos primigenius, wolf, fox, etc.

Mollusca—Cyrena fluminalis, Unio littoralis, Pupa angustior, Helix fruticum, H. ruderata, Cyclostoma elegans, and all the still existing shells.

Glacial (Marine) Mollusca—Pecten islandicus, Panopea norvegica, Tellina balthica, T. calcarea, Cyprina islandica, Trophon truncatus, Fusus antiquus, Natica clausa, Purpura lapillus, Trochus tumidus.

PLIOCENE.

Norwich Crag, including the Chillesford Beds.

Mammalia—Mastodon, Cervus carnutorum, Castor Europæus, Elephas meridionalis.

Mollusca—Littorina littorea, L. rudis, Turritella terebra, Buccinum undatum, Scalaria Greenlandicus, Conovulus pyramidalis, Mya arenaria, Tellina calcarea, Scrobicularia piperata, Cardium edule, Cardium Greenlandicum, Mactra elliptica, Leda limatula, Rhynchonella psittacea.

Red Crag.

Mammalia—Mastodon arvernensis, Rhinoceros, Tapir, Cervus dicranios, Sus arvernensis, Ziphoid and Spermaceti Whales.

Fish—Carcharodon megalodon, Oxyrhina hastalis, Raia antiqua.

Echinoderms—Echinocyamus pusillus, Aster rubris.

Molluscs—Voluta Lamberti, Buccinum Dalei, Cassidaria, Fusus antiquus, F. gracilis, Nassa reticosa, N. elegans, Littorina littorea, Trochus subexcavatus, Cypræa avellana, Emarginula crassa, Pecten opercularis, P. pusio, Ostrea princeps, O. edulis, Cardium Parkinsoni, Nucula Cobboldii, Pectunculus glycimeris, Tellina obliqua, T. prætenuis, Terebratula grandis.

Corals—Balanophyllia calyculus, Sphenotrochus intermedius.

Coralline Crag.

Mammals—Mastodon Borsoni, large Cetacea.

Fish—Oxyrhina, Otodus, Lamna, Carcharodon, and many forms of the recent gadoids—as cod, hake, whiting, etc.

Crustacea—Gonoplax angulata, Ebalia Bryerii, Cancer pagurus, Balanus porcatus.

Radiata—Echinus Woodwardi, E. Lyellii, Brissus scillæ, Temnochinus excavatus.

Mollusca—Cassidaria bicatenata, Pyrula, Triton connectans, Trophon alveolatum, Natica multipunctata, Turritella incrassata, Emarginula fissura, Scaphander Loveni, Capulus Hungaricus, Pecten maximus, P. princeps,

Venus casina, Pholadomya histerna, Astarte mutabilis, Lutraria elliptica, Isocardia cor, Cardita senilis.

Polyzoa—Lepralia, Membranipora, Fascicularia, etc.

Corals—Flabellum Woodii, Cryptangia Woodii.

UPPER EOCENE.

Mammals—Anoplotherium, Palæotherium, Dichobune, Cheiropotamus, Hyopotamus.

Chelonia—Emys, Trionyx.

Fish—Lepidosteus.

Mollusca—Cerithium austeni, Natica labellata, Nematura, Bulimus ellipticus, Achatina costellata, Paludina lenta, Planorbis euomphalus, P. discus, Lymnea longiscata, Cyclotus cinctus, Helix globosa, H. vectensis, Cyrena pulchra, C. obovata, C. semistriata, Ostrea vectensis, Unio Gibbsii.

Crustacea—Balanus.

MIDDLE EOCENE.

Barton Clay.

Mollusca—Rostellaria ampla, Murex minax, M. asper, Triton argutus, Cancellaria evulsus, Fusus porrectus, F. perrans, Pyrula nexilis, Strepsidura bulbus, Typhis pungens, Conus deperditus, Pleurotoma exorta, P. macilenta, P. priscus, P. attenuata, Cassidaria, Cassis, Natica, Turritella, and many other recent genera, Chama squamosa, Crassatella sulcata, Nucula similis, Pecten carinatus, Leda minima, Cardium Edwardsii.

Bracklesham and Bagshot Beds.

Fish—Myliobatis toliapicus, Pristis, Ætobatis lamna, etc.

Mollusca—Nautilus, Voluta, Cypræa tuberculosa, C. Bowerbankii, Fusus longævus, Seraphs terebellum, Natica crassilabrum, N. Wilmettii, Turritella sulcifera, Cerithium cornucopiæ, Ostrea flabellula, Cardita planicostata, C. Brongniarti, Arca Branderi, Sanguinolaria Hollowaysii, Solen, Corbula Gallica, etc.

Corals — Dendrophyllia dendrophylloides, Litharea Websteri.

Plants—(Bagshot) Cinnamonium, Dryandra, Osmunda, Sequoia, Pteris cæsalpina, Aralia, Ficus, Laurus, Vitis, etc.

LOWER EOCENE.

London Clay.

Mammals — Coryphodon, Hyracotherium, Didelphys.

Birds—Halcyornis toliapicus, Lithornis vulturinus, Odontopteryx toliapicus.

Reptiles—Crocodilus champsoides, Palæophis toliapicus, Trionyx, Chelone, etc.

Fish—Lamna, Otodus, Myliobatis, Pycnodus, Carcharodon, Pristis, Cœlopoma, etc., etc.

Echinoderms—Ophiura Wetherellii, Astropecten crispatus, Pentacrinus subbasaltiformis.

Crustacea—Xanthopsis Leachii, Hoploparia gammaroides, Xanthulithes Bowerbankii, Dromilites Lamarckii.

Mollusca—Teredina personata, Panopea intermedia, Axinus angulatus, Pectunculus brevirostris, Leda amygdaloides, Nucula simplex, Pinna affinis, Astarte rugata, Aturia ziczac, Nautilus imperialis, Pyrula Smithii, Rostellaria lucida, Voluta denudata, Phorus extensa, Cerithum, etc., etc.

Corals—Paracyathus caryophyllus.

Fruits—Petrophiloides, Cucumites, Faba, Nipadites, Wetherellia, Cupanoides, etc.

Woolwich and Reading Beds.

Fish—Lamna.

Mollusca—Pitharella Rickmanni, Paludina aspera, Neritina globulus, Melania inquinata, Cerithium funatum, Cyrena cuneiformis, C. Dulwichiensis, C. cordata, Ostrea bellovicina, O. tenera, Arca Dulwichiensis.

Oldhaven Beds.

Same as Woolwich and Reading, with rather more marine remains—C. tellinella, Melanopsis subcarinata, Pectunculus terebratularis, Cyprina Morrisii, Pleurotoma, etc.

Thanet Sands.

Mollusca—Cyprina Morrisii, Cytherea orbicularis, Glycimeris Rutupiensis, Thracia oblata, Panopea granulata, Pholadomya Koninckii, Arca crassatina, Aporrhais Sowerbyi, Scalaria Thanatiana.

CHALK.

Reptilia—Ichthyosaurus campylodon, Leiodon anceps, Mososaurus Hoffmannii, Chelone Benstedi, Pterodactylus giganteus.

Fish—Beryx, Tetrapterus, Osmeroides, Corax, Notidanus, Otodus, Lamna.

Crustacea—Astacus Leachii, etc.

Echinodermata—Goniaster, Oreaster, Marsupites, Bourgueticrinus, Cidaris clavigera, C. sceptrifera, Cyphosoma Konigii, Micraster cor anguina, Ananchytes ovatus, Galerites albogalerus, etc.

Annelids—Serpula plexus.

Mollusca—Baculites, Nautilus elegans, Ammonites peramplus, A. Mantelli, A. varians, A. falcatus, Pleurotomaria, Rostellaria, Lima Hoperi, Plagiostoma spinosus, Inoceramus Cuvieri, Ostrea frons, Pecten nitidus, Terebratula semiglobosus, Rhynchonella plicatilis.

Corals—Parasmilia centralis, Caryophyllia laxa, Bathycyathus Sowerbyi.

Sponges—Ventriculites, Siphonia, Polypothecia, Choanites, etc.

Foraminifera—Lituola, Textularia, Dentalina, Globigerina, Rotalia, etc., etc.

UPPER GREENSAND AND GAULT.

Reptiles—Polyptichodon, Ichthyosaurus, etc.

Fish—Lamna, Portheus, Ischyodus.

Echinodermata—Cidaris gaultina, etc., etc.

Annelida—Serpula antiquata, etc., etc.

Crustacea—Corystes Stokesii, C. Broderipii, Etuuys Martini.

Mollusca—Hamites Helicoceras, Ancylocerus, Ammonites splendens, A. radians, A. tuberculatus, A. lautus, Rostellaria, Trochus, Dentalium ellipticum, Solarium ornatum, Scalaria gaultina, Inoceramus sulcatus, I. concentricus, Nucula pectinata, Terebratula biplicata, Magus pumila.

Corals—Cyclocyathus Fittoni, Bathycyathus, Trochocyathus conulus.

Sponges—Siphonia, Polypothecia, Jerea, etc.

Plants—Sequoia and Pinites.

LOWER GREENSAND.

Reptiles—Polyptichodon interruptus, Ichthyosaurus, Dakosaurus, Ignanodon.

Fish—Hybodus basanus.

Crustacea—Hoploparia longimana, Meyeria ornata, Meyeria vectensis.

Echinodermata—Salenia punctata, Cidaris, etc.

Mollusca—Ammonites Deshayesii, Ancyloceras, Crioceras, Rostellaria Fittoni, Cinulia natica, Turbo, Vicarya, Pecten interstriatus, Ostrea macroptera, Nucula, Leda, Mytilus, etc., Terebratula tamarindus, T. biplicata, T. Davidsoni, Rhynchonella depressa, R. nuciformis, etc.

Corals—Holocystis elegans.

Sponges—Scyphia furcata, Manon peziza, Chenondopora fungiformis, Verticellitis anastamosans.

Plants—Zamiostrobus Sussexiensis.

WEALD.

Reptiles—Hylæosaurus, Iguanodon Mantelli, Hypsilophodon Foxii, Goniophilis crassidens, Megalosaurus, Streptospondylus, Regnosaurus, etc., Pterodactylus, Chelone Mantelli, Platermys Bowerbankii.

Fish—Lepidotus Mantelli, L. Fittoni.

Crustacea—Cypridea valdensis.

Mollusca—Unio valdensis, Cyrena media, Paludina elongata, P. Sussexiensis.

Plants—Sphenopteris Mantelli, Zamiostrobus crassus, Endogenites erosa. Cycadites Brongniarti, Clathraria Lyellii, Sequoia, Alethopteris elegans.

UPPER OOLITE.

Mammals—Spalacotherium, Triconodon, Plagiaulax, etc.

Reptiles—Goniopholis, Cetiosaurus, Megalosaurus, Omosaurus, Macellodus, Nothosuchus, Suchosaurus, Nothetes. *Chelonia*—Chelone obovata, C. planiceps, etc.

Fish—Asteracanthus vernicosus, Caturus angustus.

Insects of all orders.

Echinodermata—Hemicidaris Purbeckensis.

Mollusca—Ammonites biplex, Pleurotomaria, Cerithium Portlandicum, Natica, Cardium, Pecten lamellosus, Trigonia incurva, T. gibbosa, Perna, etc.

Corals—Isastrea oblonga.

Plants—Mantellia nidiformis, Coniferous wood, etc.

MIDDLE OOLITE.

Reptiles—Pterodactyles, Cardiodon, Ichthyosaurus trigonus, Pliosaurus grandis, P. trachydeirus, Steneosaurus rostro minor, Dakosaurus.

Fish—Leptolepis, Aspidorhynchus, Asteracanthus, Ganodus, Ischyodus, Gyrodus Cuvieri, Hybodus apicalis, H. grossicomus, Strophodus magnus, etc.

Crustacea—Glyphea.

Echinoderms—Hemicidaris intermedia, Cidaris florigimma, Holectypus, Clypeus Plottii, C. Milleri, C. Navicularis, Diadema, Cyphosoma, Stomechinus, etc.

Mollusca—Ammonites Jason, A. variabilis, A. Lamberti, A. Brocchii, A. Blagdeni, etc., Pleurotomaria ornata, P. reticulata, Phasianella striata, Chemnitzia Heddingtonensis, and many species of the genera Pecten, Plagiostoma, Cardium, Astarte, Pholadomya, Goniomya, etc., Diastopora diluviana, etc., Terebratula maxillata, T. digona, T. simplex, T. carinata, T. obovalis, Rhynchonella concinna, Rhyn. varians, Rhyn. marginalis.

Corals—Calamophyllia radiata, Cladophyllia Conybearii, Isastria helianthoides, I. explanata, Stylina tubulifera, Thamnastrea arachnoides, T. concinna, Thecosmilia annularis, Montlivaltia dispar.

LOWER OOLITE.

Mammals—Phascolotherium Bucklandi, Amphitherium Prevostii, A. Broderipii, Stereognathus.

Reptiles—Pterodactyle, Cetiosaurus longus, C. magnus, Streptospondylus Cuvieri, Ichthyosaurus, Pliosaurus, etc.

Fish—Lepidotus, Acrodus, Hybodus, Strophodus, etc.

Mollusca—Nautilus Baberi, Ammonites Parkinsoni, A. anceps, A. communis, A. oxynotus, A. polymorphus, A. contractus, Cylindrites acutus, Purpurina Morrisii, Amberlya nodosæ, Lima cordiiformis, L. rigidus, Pecten vagans, P. opercularis, Placunomia socialis, Perna rugosa, Mytilus cuneatus, Astarte angulatus, Pholadomya Heraultii, P. Murchisoni, Trigonia impressa, Trigona clavellata, Terebratula Phillipsii, T. lagenalis, T. impressa, Rhynchonella cynocephala.

Echinoderms—Echinobrissus, Apiocrinus rotundus, Cidaris propinqua, C. Fowleri, Echinus granularis, etc.

Corals.—Anabacia orbulites, A. hemisphærica, Axosmilia, Cladophyllia Babearii, Isastrea serialis, I. Conybeari, Stylina Delabechei, Thamnastrea scita, T. Waltoni, T. Lyellii, Thecosmilia gregaria, Montlivaltia trochoides.

Plants—Hæmopteris, Pterophyllum, Equisetitis lateralis, Palæozamia, Hymenophyllites, etc.

XXXIII.

THE MOON (*continued*).

THE entire visible surface of the moon may be divided into three great classes, under which the whole of the diversely constituted lunar surface may be grouped. These are the *plains*, *mountains*, and *craters*.

The first class, which occupies more than one half of the entire lunar surface, may be divided into the two great sub-classes of *dark* and *light* plains. The first includes the lunar *seas*, or *maræ*, and the latter includes a smaller class of level plains generally elevated considerably above the rest of the surface. Under the single term *crater* we may group the entire series of lunar formation, which, when seen under a low

power in a small telescope, have been thought to resemble in appearance the terrestrial volcanoes. These may be divided into *walled-plains, ring-plains, craters, craterlets, crater-pits,* and *depressions.* Lastly, the class of mountains may be roughly divided into *mountain chains, highlands, mountains, ridges,* and *hills*; though as on the earth there exist on the moon nearly every kind of elevation, such as here would be called mounds, hillocks, rocks, landswells, etc.

Mare.—This term was applied by Hevelius to denote the great comparatively level plains indented in places by bays and gulfs, and projecting at others into long promontories. At other times the border is formed either by gently rising slopes, or by long series of low parallel ridges. When attentively scrutinised, many traces can be detected of erosion and disintegration all round these coast-lines, and frequent evidences of alluvial deposits can be clearly perceived, all pointing to the fact that in these dark-grey maria we find the dried-up beds of the ancient lunar oceans. These maria constitute about two-fifths of the entire lunar surface. They are most numerous on

A Mare Crisium.
B Palus Somnii.
C Mare Serenitatis.
D Mare Tranquillitatis.
E Mare Fœcunditatis.
F Mare Nectaris.
G Sinus Medii.
H Mare Vaporum.
I Lacus Mortis.
J Mare Frigoris.
K Mare Imbrium.
L Oceanus Procellarum.
M Mare Humorum.
N Mare Nubium.
O Sinus Iridum.

a Apennine Mts.
b Caucasus.
c Carpathians.
d Pyrenees.
e Altai Mts.
f Riphaen Mts.
g Doerfel Mts.
h Leibnitz Mts.
i Corderillas.
j D'Alembert Mts.
k Taurus Mts.
l Hæmus Mts.
m Alps.

1 Clavius.
2 Maginus.
3 Maurolycus.
4 Stöfler.
5 Tycho.
6 Longomontanus.
7 Wilhelm I.
8 Schiller.
9 Schickhardt.
10 Hainzel.
11 Furnerius.
12 Metius.
13 Fabricius.
14 Riccius.
15 Piccolomini.
16 Zagut.
17 Apianus.
18 Walter.
19 Hell.
20 Pitatus.
21 Hesiodus.
22 Capuanus.
23 Ramsden.
24 Vieta.
25 Petavius.
26 Vendelinus.
27 Langrenus.
28 Fracastorius.
29 Theophillus.
30 Cyrillus.
31 Catharina.
32 Sacrobosco.
33 Almanon.
34 Albufeda.
35 Albategnius.
36 Hipparchus.
37 Ptolemy.
38 Alphonsus.
39 Purbach.
40 Regiomontanus.
41 Thebit.
42 Arzachel.
43 Bullialdus.
44 Lalande.
45 Mösting.
46 Herschel.
47 Gassendi.
48 Mersenius.
49 Sirsalis.
50 Grimaldi.
51 Riccioli.
52 Hevelius.
53 Condorcet.
54 Taruntius.
55 Proclus.
56 Cleomedes.
57 Romer.
58 Posidonius.
59 Plinius.
60 Julius Cæsar.
61 Manilius.
62 Godin.
63 Agrippa.
64 Triesnecker.
65 Bode.
66 Gambart.
67 Eratosthenes.
68 Copernicus.
69 Reinhold.
70 Landsberg.
71 Encke.
72 Kepler.
73 Marius.
74 Archimedes.
75 Timocharis.
76 Euler.
77 Aristarchus.
78 Herodotus.
79 Struve.
80 Messala.
81 Mare Humboldtanius.
82 Atlas.
83 Hercules.
84 Endymion.
85 Eudoxus.
86 Aristoteles.
87 Linne.
88 Autolycus.
89 Aristillus.
90 Cassini.
91 Plato.
92 Helicon.
93 Pythagoras.

FIG. 85.—MAP OF THE MOON SHOWING PRINCIPAL FORMATIONS.

of the moon, which exhibit considerable resemblance to the beds of dried-up oceans or seas, though even in his time they were known not to be covered with water. These great tracts are at full moon distinctly visible to the naked eye as dark-grey spots, in places sharply separated from the purer light of the brighter portions, but in others gradually fading into them. Examined closely, they are seen to be crossed by numerous long ridges, mostly of insignificant height, and to contain many hills and crater-pits. The maria are generally bordered by lofty ranges of rugged cliffs, broken here and there by ravines, the north and east, smaller towards the centre and west, and entirely absent from the south. They are named after fanciful properties, as the Mare Vaporum (sea of vapours), Mare Nubium (sea of clouds), etc. The principal are the Oceanus Procellanum, and the Mare Imbrium, Mare Serenitatis, and Mare Tranquillitatis. They are usually from 300 to 500 miles in diameter.

Terræ.—These constitute the bright plains upon the moon, and consist of large tracts of tolerably level surface, broken here and there by low mountains and hills, and containing in places small ring-plains and crater-pits. They

are not conspicuous, and disappear on all sides into the surrounding more rugged districts. They may be compared with the more level regions of the earth. None bear distinctive names.

The Mountains.—The larger mountains on the moon are generally to be found in the form of great masses of highlands, consisting of numerous groups of mountains united by short massive arms, and enclosing broad elevated plateaux, whilst here and there rise excessively lofty peaks. These highlands are crossed by numerous winding valleys and ravines, and contain numbers of rounded valley-like depressions, taking at times the appearance of craters. They are generally much brighter than the lower-lying districts, and often form the borders to the dark *maria*; in this case they often rise at their edges into great chains of lofty peaks. Some of these great highlands extend for several hundred miles in length, are a hundred miles or so in breadth, and contain peaks rising 10,000, 15,000, and 20,000 feet above the surface beneath them. At other times the mountains form long chains of lofty peaks, united together by a lower-lying continuous crest. They often enclose lower-lying tracts of more level country, giving rise to the formation known as *walled-plains*. Several of these great ranges of mountains extend for several hundred miles in length, and near the limb of the moon there are a number containing peaks of very great altitude, their summits towering 25,000, 30,000, and even 35,000 feet above the surrounding regions, thus far exceeding in height the loftiest terrestrial mountains. Isolated mountains of any height are not common, but hills ranging in elevation from 500 to 3000 feet are very numerous. The lower-lying portions of the surface, and especially the dark seas, contain numerous long winding ridges, usually several miles wide, and rising in gentle slopes to a height of from 200 to 2000 feet. Occasionally peaks on these ridges are still higher. The larger of these mountains are named after fancied terrestrial analogies in the Alps, Apennines, Pyrenees; most of them, however, are not named.

FIG. 86.—FORMATIONS NEAR MÖSTING. MODERATE POWER.

The Craters constitute a very diversified series of formations, most of which, when attentively examined, are found to bear no resemblance to terrestrial volcanoes. Fig. 82 (p. 208) shows a portion of the surface of the moon near the ring-plain called *Mösting*, as seen by a low power, and it will be observed that it seems to consist of a number of circular depressions resembling volcanic craters. Fig. 86 shows the same region under a higher power, and it will be seen at once that the crateriform character of several of these so-called *craters* has disappeared, their true nature as mere plains surrounded by hills, ridges, and mountains being distinctly visible. The diameter of the great central enclosed plain—or Walled-plain, as it is called—is fifty miles, whilst the surrounding elevations reach a height of from 1000 to 3000 feet. A similar instance is furnished by the great ring-plain Copernicus. Seen as in fig. 83 (p. 208), under a low power, it looks much like the crater of some gigantic volcano, for its diameter is fifty-six miles, but examined under a higher magnifying power, this resemblance in great part disappears. How utterly dissimilar these formations are from the craters of volcanoes is shown by the section of Copernicus, furnished by fig. 89, where it will be seen how comparatively low the walls are, and what gentle slopes they possess. Yet the actual height of the walls is 10,000 feet; but then their breadth is 110,000 feet. These formations, though possibly they have their origin in some form of volcanic energy, or rather perhaps in the same internal forces which give rise to the true volcanoes, are entirely different in character to the terrestrial volcanoes. They rather resemble the great enclosed valleys not uncommon on the earth. Such formations are common in North America and in Europe. Bohemia may be taken as a representative instance. And though viewed from above they resemble great mountain rings, viewed from the lunar surface it is only with difficulty that this character would be recognised.

XXXIV.

Bills of Parcels, or Invoices.

Definition.—A Bill of Parcels, or an Invoice, is a list of the various articles that have been sold by one person to another, with the prices of each article annexed.

Example 1.

Mr. Charles Smith,

Bought of Messrs. Child and Wilson.

1882.		*s.*	*d.*
Jan. 1.	6 yds. of cretonne at 8½*d.* . .	4	3
„ 15.	10 yds. of chintz at 3¼*d.* . . .	2	8½
Feb. 3.	16 inches of braid at 9*d.* a yd. .	1	0
„ 27.	25 yds. of calico at 4*d.* . . .	8	4
		16	3½

Example 2.

R. Wallace, Esq.,

Bought of D. Savary and Co.

1881.		£	s.	d.
June 3.	1 work-basket	2	1	6
„ 5.	3 pair scissors at 1*s.* 6*d.* . .	0	4	6
„ „	2 albums at 17*s.* 6*d.*	1	14	8
Aug. 17.	3 dozen quires note-paper, at 3¾*d.* per quire . . .	0	11	3
Sept. 8.	5 card-cases at 4*s.* 11*d.* . .	1	4	7
		5	16	6

The student can make any number of similar examples for himself.

Ratio and Proportion.

In comparing two numbers together it is sometimes best to find by how much the one exceeds the other. This is done by subtracting the less from the greater.

But it is often necessary to compare them in another way—namely, by finding how many times the one contains the other. To do this is to find their Ratio.

Definition.—Ratio is the relation which one number or magnitude bears to another with respect to the number of times the latter number is contained in the former—*i.e.*, it is the quotient which arises from dividing the first number by the second.

Thus the ratio of 6 to 5 is the number of times that 5 is contained in 6—*i.e.* $\frac{6}{5}$, or the quotient when 6 is divided by 5. As a quotient can always be expressed as a fraction, so a ratio can always be expressed as a fraction. Thus, as we have seen, the ratio of 6 to 5 is expressed by the fraction $\frac{6}{5}$, the ratio of 3 to 4 is expressed by the fraction $\frac{3}{4}$, and so on.*

The ratio of one number to another is sometimes expressed by writing the two numbers with a colon between; thus the ratio of 3 to 4 is written 3 : 4. We see therefore that 3 : 4, $3 \div 4$, and $\frac{3}{4}$ all mean the same thing—namely, the ratio of 3 to 4.

The two numbers which form a ratio are called the "terms" of the ratio. The first term is called the "antecedent," the second the "consequent."

The *inverse ratio* of any given ratio is the ratio of the consequent to the antecedent. Thus the inverse ratio of 5 : 6 is the ratio 6 : 5.

The two numbers may be both abstract or both concrete, but not one abstract and the other concrete. It would be improper to speak of the ratio of 6 miles to the abstract number 5; but we might speak of the ratio of the abstract number 6 to the abstract number 5.

Again, if they are both concrete they must be of the same kind—that is, they must be quantities of the same nature—otherwise to speak of their ratio would be unmeaning. We can speak of the ratio of 6 tons to 5 tons, or 6 hours to 5 hours, and in each case the ratio is the *abstract* fraction $\frac{6}{5}$. But it would be unmeaning to speak of the ratio of 6 tons to 5 hours, because it would be unmeaning to ask how many times one is contained in the other.

Again, though we may speak of the ratio of 6 miles to 5 yards because they are quantities of the same nature, yet we must take care not to express this ratio by the fraction $\frac{6}{5}$. Clearly, if we ask how often 5 yards are contained in 6 miles, we must reduce the miles to yards before we divide the one by the other—*i.e.*, before we can express the ratio of the two quantities we must express them both in one and the same denomination. The ratio of 6 miles to 5 yards would therefore be $\frac{6 \times 1760}{5}$.

As the value of a fraction is not altered by multiplying or dividing both its numerator and its denominator by any number, it follows that a ratio is not altered in value by multiplying both its terms by any number, or dividing both terms by any number. Thus the ratio 3 : 5 is the same as the ratio 21 : 35, or 9 : 15, or 6 : 10, because each of these ratios can be expressed as a fraction which, when reduced to its lowest terms, is $\frac{3}{5}$.

Compounding ratios means multiplying them together, which is done by multiplying the antecedents together for a new antecedent and the consequents for a new consequent. Now, to compound the ratios 2 : 3 and 5 : 7 is to multiply one by the other—*i.e.* to multiply $\frac{2}{3}$ by $\frac{5}{7}$. The resulting ratio is $\frac{10}{21}$, or 10 : 21. The ratio compounded of the ratios 2 : 3, 5 : 7, 6 : 11, 7 : 10, is the ratio $2 \times 5 \times 6 \times 7 : 3 \times 7 \times 11 \times 10$, or the fraction $\frac{2 \times 5 \times 6 \times 7}{3 \times 7 \times 11 \times 10}$, which $= \frac{2}{11}$.

Proportion.

When four numbers are such that the ratio of the first to the second is equal to the ratio of the third to the fourth, then the four numbers are said to form a proportion, or to be in proportion.

The proportion is the statement of the equality of the two ratios. Thus, since 3 : 5 and 21 : 35 are equal ratios, we have the proportion 3 : 5 = 21 : 35, which is sometimes written 3 : 5 :: 21 : 35, and read "3 is to 5 as 21 to 35."

The four numbers or terms which form a proportion are called proportionals. Thus 3, 5, 21, and 35 are proportionals.

The first and last terms of a proportion are called "extremes," and the second and third terms are called the "means"—*e.g.*, 3 and 35 are the extremes, while 5 and 21 are the means.

Proposition :—

In any proportion the product of the extremes is equal to the product of the means.

Take the proportion 3 : 5 :: 21 : 35, then we have $\frac{3}{5} = \frac{21}{35}$. Multiply both fractions by 5×35, then this equality becomes $\frac{3 \times 5 \times 35}{5} = \frac{21 \times 5 \times 35}{35}$, or $3 \times 35 = 21 \times 5$—*i.e.*, the product

* It may be well to call attention to the fact that we are now giving a new interpretation to a fraction, having already used it in two different, yet consistent, meanings. We first used it to indicate that the unit is to be divided into a certain number of equal parts (specified by the denominator), of which a certain number (specified by the numerator) is taken. Subsequently we took it to indicate the quotient arising from dividing one number by another. And now we use it to compare one number with another. A little consideration will show the student that these three uses of a fraction are not inconsistent.

of extremes (3 and 35) = the product of means (5 and 21).

Proposition :—

If four numbers be proportional when taken in a certain order, they will be proportional when taken in the reverse order.

For, take the proportion $2 : 3 = 8 : 12$.

We have therefore $2 \times 12 = 3 \times 8$ (by the last proposition).

Now divide both of these equal products by 8×2.

Then $\frac{2 \times 12}{8 \times 2} = \frac{3 \times 8}{8 \times 2}$, or $\frac{12}{8} = \frac{3}{2}$, or $12 : 8 = 3 : 2$.

This and the last proposition the student will do well to verify for himself with other numbers.

If any three terms of a proportion be given, the remaining term can always be found.

For in any proportion we have—

1st term × 4th term = 2nd term × 3rd term

$$\therefore \text{1st term} = \frac{\text{2nd} \times \text{3rd}}{\text{4th}}$$

$$\text{2nd} = \frac{\text{1st} \times \text{4th}}{\text{3rd}}$$

$$\text{3rd} = \frac{\text{1st} \times \text{4th}}{\text{2nd}}$$

$$\text{and 4th} = \frac{\text{2nd} \times \text{3rd}}{\text{1st}}$$

Example.—Find the 2nd term in the proportion of which the other terms in order are 3, 5, 6.

We have $3 : \text{2nd} :: 5 : 7$

or $3 \times 7 = \text{2nd} \times 5$; $\therefore$ $\text{2nd} = \frac{3 \times 7}{5} = \frac{21}{5}$.

The proportion is therefore $3 : \frac{21}{5} :: 5 : 7$.

To verify this we have $3 : \frac{21}{5} = 3 \div \frac{21}{5} = 3 \times \frac{5}{21} = \frac{5}{7}$—*i.e.* $5 : 7$.

Example.—Find the 4th term of the proportion of which the other terms in order are 6, 8, 12.

We have $6 : 8 :: 12 : \text{4th term}$,

or $6 \times \text{4th term} = 8 \times 12$, $\therefore$ 4th term $= \frac{8 \times 12}{6} = 16$.

The proportion, it will be perceived, is $\therefore 6 : 8 :: 12 : 16$.

Example.—Which of the following ratios is the greatest, and which of the following ratios also is the least?—

5 : 6, 8 : 11, 31 : 33?

This and many other questions in ratios are, the student will find in the course of practice, most easily solved by expressing the ratios as fractions. We have therefore to compare the fractions $\frac{5}{6}$, $\frac{8}{11}$, $\frac{31}{33}$.

Reducing them to a common denominator, according to the rule we have given in a previous article, they become

$\frac{5}{6} = \frac{55}{66}$

$\frac{8}{11} = \frac{48}{66}$

$\frac{31}{33} = \frac{62}{66}$

$\therefore$ the ratio 31 : 33 is the greatest, and 8 : 11 the least.

Example.—Simplify the ratios 63 : 108, 156 : 132.

Here $63 : 108 = \frac{63}{108} = \frac{7}{12} = 7 : 12$,

and $156 : 132 = \frac{156}{132} = \frac{13}{11} = 13 : 11$.

VIII.

Frictional Electricity (*continued*).

Before leaving the subject of condensation, we must not omit to describe an adaptation of the condenser to the ordinary gold-leaf electroscope, so as to convert it into the condensing electroscope. This form of the instrument is shown in fig. 30. It consists, as will be seen, of the ordinary gold-leaf electroscope, with a much larger circular brass disc than usual attached to the top of the wire, from the other end of which the gold leaves are suspended. This brass plate has its upper surface well coated with shell-lac varnish, its lower surface being left bare. A precisely similar brass plate has its under surface varnished, and to its upper surface an insulating glass handle is attached, by which the plate may be lifted.

The condensing electroscope.

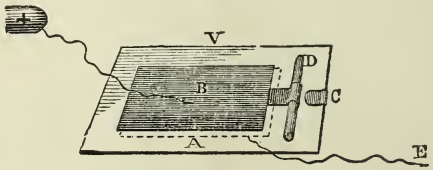


FIG. 24 (*see* p. 196).

The action of this instrument is as follows:—The varnish upon the opposed surfaces of the two discs prevents their actual metallic contact, but they are sufficiently near to act powerfully upon each other by induction. Accordingly, if repeated small charges of electricity be given to the upper disc, B, and if at the same time as these charges are given the under surface of A be touched with the finger, so as to connect it momentarily with the earth, a quantity of electricity will accumulate upon both plates, and by mutual attraction will be there held captive, so that no effect will be had upon the gold leaves, which, so long as the two discs are in contact, will remain undisturbed. So soon, however, as the upper disc is removed, the electricity upon the lower disc, being liberated, spreads itself over the wire and gold leaves, and the latter diverge with electricity of the opposite kind to that with which the upper plate, and therefore the body under examination, was charged. The theoretical explanation of this will be readily understood by those who have mastered what has been previously said about induction. Suppose the charge given to the upper disc B to be positive, this will act inductively upon the neutral electricity of A, attracting its negative and repelling its positive. The repelled positive escaping to the earth, A is left charged with negative electricity, which by a repetition of the process gradually accumulates, but being held bound by the positive of B, cannot escape from the plate until, B being removed, it is set free.

Theoretical explanation.

FIG. 25.—LEYDEN JAR.

Instead of employing the proof plane, the upper disc may be directly connected with the body under examination by a wire or other conductor, the under surface of the lower disc being at the same time similarly connected with the earth.

Another very useful piece of apparatus which we must briefly describe is the "Unit Jar," for measuring the charge of electricity given to an ordinary Leyden jar.

The unit jar.

As will be seen by fig. 31, it consists of a small Leyden jar, A, supported in a horizontal position by a varnished glass stem, S, its outer coating being in connection with a metal knob, C. A horizontal rod, E, which is in connection with a machine, is placed also in connection with the inner coating of A. To this horizontal rod is attached a movable arm by which the knob B may be brought to any required distance from C. Finally, from the rod C to the inner coating of the jar to be charged passes a conducting wire, while the outer coating of this latter jar is connected with the earth.

FIG. 26 (*see* p. 197).

If a charge of positive electricity from the conductor of the machine be given to the inner coating of A, the outer coating will become negatively charged. In the same way the inner coating of the large jar becomes charged with positive (repelled from the outer coating of the unit jar), and the outer coating with negative electricity. This goes on until A becomes sufficiently charged for a spark to pass between C and B, and the negative of the outer coating of A becomes nearly neutralised. This leaves the jar D positively charged, the amount of the charge depending upon the previous accumulation of electricity in its interior, which, in its turn, depends upon the distance between B and C. The use of the unit jar is to charge another jar equally at different times, by allowing a certain number of sparks to pass between the knobs B and C.

Use of the unit jar.

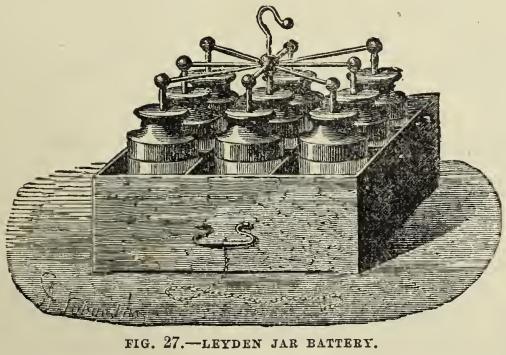


FIG. 27.—LEYDEN JAR BATTERY.

In treating of the various phenomena of induction we have hitherto considered the action of an electrified body upon a non-electrified body with which it is not absolutely in contact purely as an action at a distance, and have neglected altogether the condition of the medium (such as the air), existing between the two bodies. It is, however, necessary that we should, before quitting this branch of our subject, consider what happens to the intervening medium, and endeavour to understand the theory of induction, propounded by the great electrician, Faraday.

Dielectrics.

First let us approach the subject from the practical side. Faraday in his researches performed the following simple but instructive experiment. He took a vessel containing turpentine, and suspended in it a number of small silk threads. He then placed in the liquid two conductors, one of them charged with positive electricity and the other connected with the earth. Upon completing this arrangement all the filaments of silk were attracted towards each other, so that they joined end to end, and formed a continuous chain between the two sides of the vessel. This of course tended to show that the alternate filaments were oppositely charged, and formed a chain of elements having positive at one end and negative at the other. A more conclusive experiment even than this of Faraday was one subsequently performed by Matteucci, an Italian physicist. In this case a number of thin plates of mica were taken and placed quite close together, while the two end plates were on their outside provided with a sheet of tin-foil, in the same way as the fulminating pane of Franklin before described, with the important difference that only the outside of the terminal plates were so provided. This arrangement was then electrified, and the tin-foil removed by insulating handles. Upon examining electroscopically the condition of the plates of mica, it was found that each was charged with positive electricity on one side and with negative on the other.

Faraday's researches.

Now, it is evident, in this case, that however thin the layers into which a body may be divided, *each* layer is both positively and negatively electrified, and not half the layers of the body positively and the other half negatively endowed. By continuing in imagination the breaking up of a body into finer and finer particles until the ultimate particles or "molecules" are reached, it is quite legitimate for us to suppose that each one of *them* is also positive at one end and negative at the other. If this view of the matter be correct, we might consider an electrified body to be represented graphically as in the annexed diagram (fig. 28), which, as we shall afterwards see, represents the condition, so far as we know it, of a bar magnet.

It will be easily understood that if we accept this as probably true, all the phenomena of conduction are readily explained by it. It must of course be remembered that a molecule is essentially indivisible by physical means, so that in every body you must have a certain number of perfect molecules, while in breaking that body you cannot rupture the molecules but only separate them. This being borne in mind, no difficulty whatever will be encountered in explaining all or any of the phenomena of conduction mentioned either in these articles or elsewhere.

Explanation of conduction.

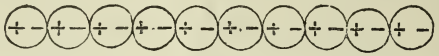


FIG. 28.

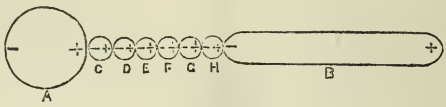


FIG. 29.

But how about induction? How can we explain this "polarisation" of the molecules, when the inducing body is unconnected with the neutral body upon which it exerts its influence? We may best answer this question by propounding another: *is* there no connection between the two bodies? A little consideration will show that, in the ordinary way, there is the connecting medium—the air—and we have only to extend our polarisation theory to this intervening medium, and all the facts of induction may be fully explained. Faraday supposed that electrification by induction was not really an action at a distance, but merely a continuous polarisation through the air particles connecting the two bodies.

Faraday's theory of induction.

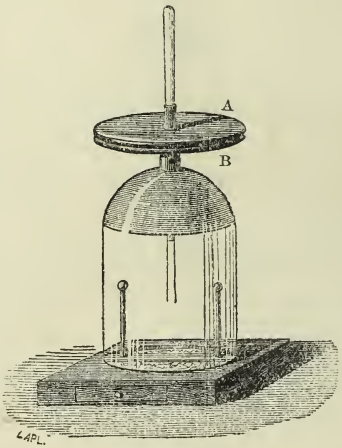


FIG. 30. (*see* p. 288).

According to this (Faraday's) theory of induction, the action of an electrified body upon another, with which it is not directly connected by a conductor, may be graphically represented as in fig. 29, where A represents the inducing electrified body, B the body upon which A is acting, and C to H a row of air particles connecting A and B.

Ingenious, however, as is Faraday's theory, it has not wanted for assailants, and some of the objections urged against it are entitled to considerable weight, the most important being that induction takes place in a vacuum. This objection would at first sight seem to be fatal to the theory: but we must remember that a *perfect* vacuum has never yet been obtained, and it may be that in the best vacuum we can at present command there still remain a sufficient number of air particles to propagate the polarisation.

Objections to Faraday's theory.

Whatever may be the value of Faraday's theory of induction, it is perfectly certain that it is necessary to consider the action of intervening media in inductive phenomena, it being clearly proved that different insulators have different capacities for transmitting electrical influence To show this, the apparatus represented in figs. 32 and 33 was employed by Faraday (see Article IX.).

Dielectric phenomena.

Here fig. 32 represents a brass sphere made up of two halves, which are made to fit very accurately into each other. In the interior of this sphere is a smaller one, also made of brass; and attached to this is a metallic rod, which terminates outside the larger sphere in a knob, B. This rod is insulated from the envelope P Q by a thick mass of shell-lac, A. Into the space *m n*, between the two spheres, the substance whose inductive capacity is to be tested is placed. The foot of the apparatus is hollow, and is provided with a screw and tap, so that it may be connected with an air-pump, and the air within P Q, if necessary, rarefied or exhausted.

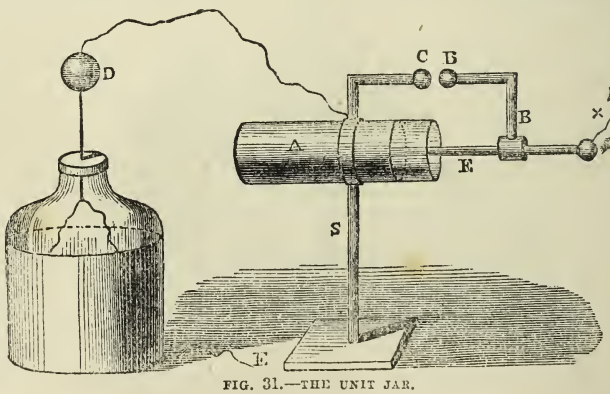


FIG. 31.—THE UNIT JAR.

It will be sufficient for our purpose if we describe one of the experiments performed by Faraday with this apparatus. Two such double

spheres precisely similar to each other were used, and in the first instance the space *m n* in each contained only air. Both the envelopes P Q were connected with the ground, and to the knob of one of them a charge of positive electricity was given. The inner sphere, therefore, in this case resembled the inner coating of a Leyden jar, and the outer envelope became charged negatively, as would under similar circumstances the outer coat of a Leyden jar. The knob B was then touched by a proof plane, and by means of the torsion balance (to be hereafter described) the quantity of free electricity was measured. In one experiment it produced a torsion of 250°. The knob B was then placed in metallic connection with the knob of the other apparatus, and upon testing, the torsion produced was 125°, thus showing that the electricity had become equally divided between the two apparatus, as might indeed have been expected.

Results of Faraday's researches.

XXXIV.

The Stuart Period in England.—Reign of James I.

Progress, development of strength, and national glory had been the characteristics of the Tudor period in England. Especially during the reign of the great queen whose rule worthily closes the annals of a line of kings, haughty and imperious indeed, and not disinclined to arbitrary measures, but thoroughly understanding the people whom they governed, we have the spectacle of obedience cordially and ungrudgingly given to a sovereign who has the wisdom to secure the nation's respect and love. With the Stuarts a new era begins—an era in which the nation is divided into factions, and the royal authority is worshipped at one time with superstitious awe, at another regarded with mingled hatred and contempt—an era during which, through a long and arduous struggle of more than sixty years, amid wars and rumours of wars, the great question was to be decided, whether the government of the British empire was to be a despotism, or whether her people were to fulfil the aspiration uttered eight centuries before by the wisest of her Saxon rulers, and to be "as free as their own thoughts."

Characteristics of the Stuart era

James VI. of Scotland and I. of England succeeded to the English throne by the right of primogeniture. He was directly descended, through his mother, Mary Queen of Scots, from Margaret, the eldest daughter of Henry VII.; through his father, the unhappy Lord Darnley, he was also a descendant of Margaret; for Darnley was the grandson of Margaret by her second husband, Archibald, Earl of Angus. His title was not altogether indefeasible; for Henry VIII. had, according to a statute passed to enable him to dispose of the succession to the crown by will, executed a testament—in which, in the event of the failure of direct descendants from his children, he left the crown to the descendants of his second sister, Mary, duchess of Suffolk, in preference to those of Margaret of Scotland. Several of the descendants of Mary were then alive; and had the testament of Henry VIII. not been set aside, their claim would have taken precedence of the pretensions of James.

Reign of James I., 1603–1625.

Nations, like individuals, have their periods of childhood, maturity, and decay; and the English nation had been rapidly growing, during the last century, from the childhood of feudalism to the vigorous manhood of self-government. It was impossible that the Englishmen of the seventeenth century should be satisfied with the conditions under which their ancestors of the days of Edward IV. and Henry VI. had been content to live. Increased education and augmented wealth gave a great additional importance to the middle classes. In Scotland, on the other hand, the government was still feudal. James had been accustomed to annoyance, and even danger, from two quarters—the nobles, and the presbyterian clergy; and accordingly he feared the former class, and cordially detested the latter. His authority had been frequently set at naught by the great chiefs, and he had even been kept in a kind of captivity; but he had no idea of the strength of the law,—he could understand the menaces of a noble, but was immeasurably indignant at the restraints imposed by a house of commons.

Scotland and England compared.

The accession of James was generally welcomed in England. The old queen had not been herself for the last two years of her reign, and her popularity was gone. "Foreigners were shocked," says Carte, "on James's arrival, at the applause of the populace who had professed to adore the late queen; but in fact she had no huzzas after Essex's execution." But James's conduct soon alarmed all who put a value on liberty. By the time he reached London the admiration of the intelligent world was turned into contempt. At York, as if in defiance of the opinion of a law-abiding people, he caused a cutpurse caught in the act of robbery to be hanged without any form of trial. "If the wind bloweth thus," aptly remarked Sir John Harrington, "why may not a man be tried before he has offended?" Within a very short time he managed to disgust all classes by his uncouth manners, and the ill-considered, blustering and undignified speeches he stuttered forth. The ludicrous contrast between his lofty pretensions and his miserable performance irritated and exasperated those whom the royal pedant sought to impress and intimidate. Learned without breadth or liberality of mind, arrogant without courage, he was continually talking in the highest strain of his prerogative, and of the paramount duty of subjects to submit themselves unconditionally to the royal will: yet, whenever he found him-

Unpopularity of the new king.

self confronted by the determined resistance of his parliament or people, he gave way, retreating with all the signs of fear, and making concessions with a grudging and discomfited air that robbed his favours of all dignity and grace. Priding himself on his kingcraft, he was egregiously outwitted. He has been likened to the *chulo* in a Spanish bull-fight, who exasperates the bull by flaunting a red rag before it, and who occasionally throws a dart sharp enough to sting, but too small to injure. And this king, so meddlesome and yet so temporizing, so vaunting and yet so incapable, came to rule in England when a mighty movement had begun, which would have taxed the skill of Elizabeth to direct,—a general desire for improvement, an impatience of abuses, and a rapid growth of freedom of opinion and speech—the natural result of a glorious half-century of progress.

Character of James I.

Lord Macaulay's portrait of James shows in a few felicitous words the nature of the monarch whose ignoble character was faithfully reflected in his feeble reign. "The most ridiculous weaknesses," says the historian, "seemed to meet in the wretched Solomon of Whitehall; pedantry, buffoonery, garrulity, low curiosity, the most contemptible personal cowardice. Nature and education had done their best to produce a finished specimen of all that a king ought not to be. His awkward figure, his rolling eye, his rickety walk, his nervous tremblings, his slobbering mouth, his broad Scotch accent, were imperfections which might have been found in the best and greatest man. Their effect, however, was to make James and his office objects of contempt, and to dissolve those associations which had been created by the noble bearing of preceding monarchs, and which were in themselves no inconsiderable fence to royalty.

JAMES I.

The millenary petition, signed, not as it purported to be, by 1,000, but by 825 ministers, and intreating the alteration of certain points of practice and discipline in the church, obnoxious to a portion of the clergy, was presented to James on his way to London, and led to the conference at Hampton Court, held some time later, to settle the points between the episcopalians and puritans. But James was little inclined to favour the puritans, who, he conceived, failed in respect and deference to rulers and dignities; or the Roman Catholics, who, he declared, placed the pope where the king ought to be. His great predilection was for ecclesiastical government by bishops, who acknowledged the king as supreme head in the church as in the state. His motto was, "No bishop, no king." Against the puritans, moreover, he had a personal grudge. In Scotland the presbyterians had carried matters with a high hand in the days of his weakness, and he was determined to punish them now that he felt his strength. His sentiments were fully shown in the conference called at Hampton Court in 1604, ostensibly to effect a compromise between the prelatists and puritans. The king, who took part in the conference, was shamefully partial to the bishops, and browbeat their opponents in unkingly style. The subserviency of the bishops to James is exhibited in the preface to the authorized version of the Bible—a new translation begun in 1607 and completed in 1610. James, who valued himself greatly on his wisdom and sagacity, was flattered at the designation of the "modern Solomon," bestowed upon him by the obsequious prelates.

Millenary Petition.

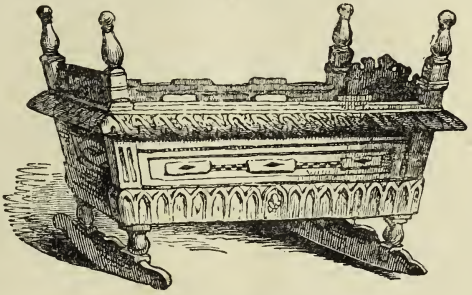
James I. and episcopacy.

From the very commencement of his reign James gave evidence of the exaggerated notions he entertained concerning the dignity of princes and the extent of their authority. According to him, absolute power was the king's undoubted prerogative; passive obedience and utter abnegation of all rights and privileges, the political annihilation involved in the word non-resistance, the only true loyalty on the part of a subject. "Although a good king," says the royal Solomon in one of his treatises, "will frame all his actions according to the law, yet he is not bound thereto, but of his own will, and for example-giving to his subjects." In fact, according to him, the divine right of kings absolved the monarch from all responsibility to any man or body of men; and had James endeavoured to carry out his doctrines in practice, or insisted on exercising the power of which he declared himself to be possessed, he could not have retained his crown for a year. The house of commons, on the other hand, understood its privileges and was determined to guard them. Some members there were, indeed, whose pusillanimity would have given up the contest—like the representative who declared in his place, "The prince's command is like a thunderbolt; his command upon our allegiance like the roaring of a lion: to his command there is no contradiction;"—but the general feeling of the house was manifested in the temperate and manly words of the vindication or "apology" prepared by a committee for presentation to the king. "What cause we, your poor commons, have to watch over our privileges," they de-

Doctrine of divine right and passive obedience.

The house of commons.

clared, "is manifest in itself to all men. The prerogatives of princes may easily and do daily grow. The privileges of the subject are for the most part at an everlasting stand. They may be, by good providence and care, preserved; but being once lost, are not recovered but with much disquiet." And with regard to religious grievances they declare, "Your majesty would be misinformed if any man should deliver that the kings of England have any absolute power in themselves, either to alter religion—which God defend should be in the power of any mortal man whatsoever—or to make any laws concerning the same, otherwise than as in temporal causes, by consent of parliament." The foolish king could see in this grave and weighty remonstrance nothing but "a new trick of contradiction" among the parliament; and in a letter to a friend declared he would rather live "like a hermit in a forest" than be "a king over such a people as the pack of puritans are that overrules the lower house." Thus James entirely failed to discern the signs of his time. He did not see that the greater part of the power lost by the feudal houses, who had been ruined by the contests of York and Lancaster, had been transferred not to the king but to the commons; and was never able to learn the purport of those weighty words—memorable in the history of England,—"by consent of parliament."



CRADLE OF JAMES I.

HAMPTON COURT PALACE.

CHEMISTRY.

XXXII.

SILVER.

THIS beautiful metal has been known from the earliest ages. It is met with native, and also combined with sulphur, chlorine, and other substances. Traces of silver are generally found to exist in galena, already spoken of a the ore of lead. This may be extracted with profit, even when only present in very small quantities, owing to the fact that the greater portion of the lead may be separated in the crystalline form, leaving behind a compound very rich in silver. The process by which the silver is finally liberated is known as cupellation. This consists in spreading the mixture on a porous bed of phosphate of lime or bone earth, and subjecting the whole to a very high temperature in a reverberatory furnace. The result is the complete oxidation of the whole of the lead present, which is accelerated by causing a blast of air to pass constantly over its surface. The oxide of lead or litharge, thus formed, fuses under the influence of the intense heat, and either flows off its surface in the liquid form, or sinks into the porous bed on which it rests, leaving the silver exposed in the metallic state. Various other methods are employed for extracting the silver from its different ores, in all of which mercury plays an important part, forming as it does an amalgam with silver.

Silver in lead ore.

Cupellation.

Silver amalgam.

This metal is too well known for us to describe its appearance. Of its properties we may say that it is both malleable and highly ductile, although in a less degree than gold. It does not readily oxidize, but combines freely with sulphur, and is one of the best, if not the very best, conductor of heat and electricity known. Silver in the molten state possesses the singular property of taking up or absorbing the oxygen of the atmosphere. This is termed occlusion. As the silver cools the oxygen gradually escapes from it, giving rise to what is termed the spitting of silver, when in this condition.

Occlusion of oxygen.

Silver is seldom or never wrought in the pure state into articles of ornament or use, being generally alloyed with a greater or less proportion of

Silver alloys.

copper. Our silver coinage contains 7½ per cent. of that metal.

Although silver does not combine readily with oxygen, and is not met with native, in the form of an oxide, yet it can be made to combine with that element in three different proportions. The first, the suboxide, is a very unstable compound; the second, a monoxide, being the only important one of the series, and the base of the different silver salts. The third is a dioxide.

Oxides of silver.

Salts of Silver.

The most important of these is the nitrate, $AgNO_3$. The transparent tabular crystals of this salt are soluble in water. When fused and cast into sticks it forms the well-known substance lunar caustic. The facility with which the silver salts are decomposed, by the action of the light of the sun, points to their use in connection with the art of photography and the preparation of marking ink. We may write with the colourless solution of argentic nitrate, spoken of above, whatever we please on a sheet of paper, employing a new quill pen for the purpose, and the writing shall be invisible as long as the paper is kept in darkness. On exposure to the light, however, the writing soon becomes visible, owing to the decomposition of the nitrate. The black colour assumed by the silver is either due to its existing in a state of exceedingly fine subdivision, or to the formation of an oxide. Silver chloride, although insoluble in water, is soon blackened by the action of light. This important salt of silver is met with native, and is then technically known as horn silver. It can be prepared artificially by bringing the solution of a chloride into contact with a silver salt, and is then precipitated as a white curdy mass. The blackening process we have mentioned is much more rapid in the presence of organic matter; hence the value of this salt for photographic purposes. The use of sodium hyposulphate in connection with that art may be explained in the following manner: a solution of that salt serves to dissolve any of the silver chloride that may remain in the unaltered state, thus rendering the image permanent, or, as it is termed, fixing the photographic picture. Silver chloride is likewise soluble in hydrochloric acid and in ammonia. The presence of any silver salts in a solution may readily be detected by the formation of a white curdy precipitate on the introduction of a soluble chloride. Silver chloride may be decomposed under the blowpipe, and may also be reduced from its solutions by the action of other metals. Silver unites very readily with sulphur, forming a dark-coloured compound. This may be observed to spread over and tarnish the surface of silver and plated goods exposed to the action of an atmosphere in which coal gas is burning, owing to the sulphur present, which, although small in quantity, is sufficient to produce this effect. Silver bromides and iodides likewise exist, but they are of little importance.

Silver nitrate, or lunar caustic.

Effect of light on silver nitrate.

Silver chloride.

Silver salts in photography.

Fixing the image.

Test for silver salts.

Silver sulphide.

GOLD.

This celebrated metal, which from time immemorial has been regarded as the most precious of all the metals, and has ever been recognised as the type and symbol of wealth, is always found native or in the metallic state. Gold is met with in the form of nodules, or nuggets as they are termed, embedded in the crystalline form of silex, known as quartz. As veins of this substance are met with in certain geological formations, occurring in various parts of the world, it follows that gold is tolerably widely distributed; it does not follow, however, that it will always be found present in sufficient quantities to pay for the working. Quartz occurs abundantly in many parts of the United Kingdom, especially in the more mountainous districts, but hitherto the extraction of the gold it contains has not proved a remunerative speculation. The quartz formations of Australia, California, and other parts of the globe, are much richer in the precious metal. Gold is also found embedded in alluvial soil, and in small grains or scales among the sand of rivers; in both of which cases, however, it has doubtless, in the first instance, been washed out of the disintegrated quartz on the mountains. Gold mining may therefore take three different forms,—digging for nuggets, embedded in the soil at the foot of mountain ranges; washing the sand of rivers for gold dust; or crushing the auriferous quartz in mills and shaking up the pulverised rock with mercury, so as to take up the gold by amalgamation. Gold does not lose its brilliant lustre in damp or dry air, nor is it attacked by any of the acids we have hitherto mentioned. Gold is exceedingly malleable, and can be beaten out into sheets of the utmost tenuity. This constitutes the gold-leaf that is used in gilding; a spurious imitation, known as Dutch metal, costing one-tenth the price of gold, and which tarnishes very rapidly, is often substituted for the more precious material. Care should therefore be taken to ascertain that pure gold-leaf is in every case made use of for the purpose of gilding frames, cornices, and other ornamental articles. A film of gold has been produced of such exceeding tenuity as actually to transmit light through its substance, which appeared, under these circumstances, of a pale green colour. Gold is likewise exceedingly ductile—that is to say, it can be drawn out into threads or wires of the most hair-like fineness. This property renders it especially valuable to the jeweller or goldsmith, as it may be wrought into the most delicate and fantastic devices. Speaking of the jewellers' art, Ruskin,

Gold found native.

The matrix of gold.

How gold is met with in nature.

Gold mining.

Gold does not oxidize readily.

Gold leaf.

Dutch metal.

Ductility of gold.

in an eloquent passage, says: "Gold has been given us, among other things, that we might put beautiful work into its imperishable splendour, and that artists, who have the most wilful fancies, may have a material which will drag out and beat out as their dreams require, and will hold itself together, with fantastic tenuity, upon whatever rare and delicate service they may set it."

Ruskin on gold.

We have already said that none of the acids hitherto spoken of will attack gold. Nitric acid, or aqua fortis as it is commonly termed, is used by the jeweller to test the purity of gold, which it does by attacking the metal with which it is adulterated or alloyed; and it is therefore just because it does not attack gold that it is available for this purpose. The only acid which does attack gold is a compound acid consisting of a mixture of nitric and hydrochloric acids, and known as aqua regia or royal water. The action of this acid on gold may probably be ascribed to the fact that that metal has more affinity for chlorine than for oxygen, its combination with that element being, however, facilitated by the presence of the powerful nitric acid.

Gold resists the action of aqua fortis.

Aqua regia.

Although exhibiting but a feeble affinity for oxygen, two oxides of gold can be obtained by artificial means—a suboxide and a trioxide. Neither of these oxides acts as a base with acids to form salts; but the latter unites with other metallic bases forming what are termed aurates. Such a compound as is represented by the formula KAuO would be termed potassium aurate.

Oxides of gold.

Aurates.

As might be anticipated from the very slight tendency gold exhibits to unite with oxygen, its compounds with that element are very unstable; the action of direct sunlight being sufficient to decompose the trioxide. Two chlorides of gold are likewise known to exist—a monochloride and a trichloride. The latter, the most interesting and important of the gold compounds, is obtained by dissolving gold in aqua regia, and evaporating the solution, when crystals of gold trichloride and hydrochloric acid are deposited. Gold trichloride also forms crystalline compounds with the alkaline chlorides. If a current of ammonia, in the form of gas, be passed through a solution of gold trichloride a brown precipitate is formed, which appears to be a compound of gold trioxide and ammonia. This precipitate when dry forms a yellow-brown powder, which explodes by percussion or when heated to 100°, and is known as gold fulminate. The addition of any of the salts of iron to a solution of a gold salt likewise gives a brown precipitate, which in this case, however, consists of metallic gold in a state of fine subdivision. The addition of the two chlorides of tin to the solution of a gold salt gives the magnificent purple colour called purple of Cassius.

Gold trichloride.

Fulminating gold.

Purple of Cassius.

The art of electro-metallurgy, which has entirely superseded the old method of plating or covering vessels made of inferior metal with a thin coating of gold or silver, spoken of under the head of mercury, is based upon the fact that the salts of the precious metals, when held in solution, can be decomposed by electrolytical action—that is, by passing a continuous current of electricity through the solution. The vessel, or other article to be plated, is suspended in the bath, as the solution is technically termed, and is gradually and equably covered by a thin deposit of gold or silver, through the decomposition of the metallic salt by electric action.

Electro-plating.

The bath.

Gold is never wrought in an absolutely pure state, either into coins or articles of jewellery. It is always alloyed to a greater or less extent, the metals generally employed for that purpose being silver and copper. The gold of our coinage is what is termed 22 carats fine—that is to say, eleven out of every twelve parts consist of pure gold. What is termed jeweller's gold is 18 carats fine—that is, in the proportion of three parts of gold to one of alloy. Gold is an exceedingly weighty metal: as compared with lead—itself a heavy metal—it is about in the proportion of 19 to 11, while it is nearly two and a half times as weighty as iron.

Alloys of gold.

Various degrees of fineness.

Weight of gold.

VII.

MASS.

§ 27. Attention must now be drawn to a point which we have hitherto ignored. Nothing has been said as to the measurement of mass. If there were only one kind of matter in the world there would be no difficulty. We might measure the mass of a body by weight, by volume, by value, or in many other ways. Two pounds of lead contain twice as much matter as one pound of lead: two cubic inches of lead contain twice as much matter as one cubic inch of lead. So long, then, as we have to deal with only one kind of matter, we may choose any one of these methods of measuring the quantity of matter in a body. But when we have to deal with different kinds of matter, a difficulty arises. Shall we say, for instance, that a pound of lead contains just as much matter—that it has the same mass—as a pound of glass? Or shall we say that a cubic inch of lead and a cubic inch of glass contain equal masses? Or is some other method necessary?

Unit of mass, Unit of force.

Of these methods we select the first; and we say that one pound of lead, one pound of glass, one pound of water, one pound of anything

you like to mention, all contain equal quantities of matter; they are equal masses. I will now try to explain the grounds upon which we make this selection.

If we take, for example, a pound of lead and a pound of glass, the weights of these two quantities are equal; in other words, the forces exerted by the earth upon them are equal.* If they were left to the action of these forces they would fall, and we find from experiment that the accelerations are equal. Hence we infer that the masses are equal—for if one mass were greater it would not be so much accelerated as the other.

This arrangement will not hold good if we take a cubic inch of lead and a cubic inch of glass. The force of the earth upon the lead—or the weight of the lead—is greater than that of the glass; and as the same acceleration is produced in the lead and the glass, we see that the mass of the lead must be greater than the mass of the glass; because, if it were not so, the greater weight of the lead would produce a greater acceleration.

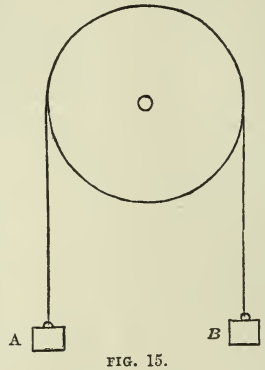


FIG. 15.

Having now fixed upon our method of measuring masses, it will be convenient to agree upon a unit of mass. It would lead to confusion if we spoke, now of pounds, now of tons, and now of grains. We shall therefore select a pound as our unit of mass; and we have the authority of an Act of Parliament to support us, if that is any recommendation. In speaking of the mass of a body as 5, we shall understand that it is a mass of 5 lb.—and so on.

It will be well to have a proper name for our unit of force. You will remember that this unit of force is the force which, acting upon a mass of 1 lb. (the unit of mass) gives rise to an acceleration 1: that is to say, this force makes the mass change its velocity, so that at the end of each second it is moving 1 ft. a second faster than at the beginning. It has been proposed to call this unit of force a *poundal*, and we will adopt the name.

§ 28. Now, perhaps some of my readers will be inclined to object to the conventions of the last two or three sections. They may urge that a pound is a weight, a force, and not a mass, and that there is no necessity for the word poundal.

Weight and mass.

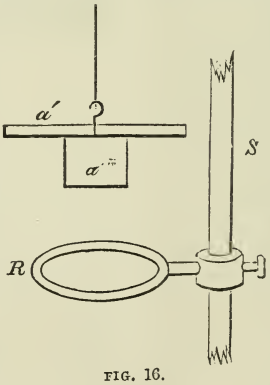


FIG. 16.

In answer it must be noticed that the word "pound" is used ambiguously. When a man says "I can lift so many pounds," or when he speaks of the pressure on a steam boiler as being so many pounds on each square inch,—then a pound is used as a measure of force. But in the large majority of cases it is used as a measure of mass. A person buying a pound of butter, say, does not trouble about the force with which the earth attracts the butter: what he wants is a certain quantity of butter, a certain *mass*. The chemist who tells you that in 100 lb. of water there are 11 lb. of hydrogen is not really thinking of the attraction of the earth for these bodies; he uses weight as a convenient measure of quantity, and the "100 lb." and "11 lb." are *masses*. In everyday life, and even in some sciences, the distinction between the weight of a body and the mass which is indicated by that weight is unimportant, because people do not require to think of the force, and thus the misnomer does not injuriously affect the clearness of a sentence in which it is used. But in mechanics, on the other hand, we have to deal with both the quantity of matter concerned in any motion, and also with the forces affecting that motion. It is, therefore, essential to lucidity that we should not use any word sometimes in the sense of a force and at other times in the sense of a mass. We therefore take a "pound" in its most common meaning—viz., we take it to signify a mass. This is one reason for choosing a different name for a measure of force. Another reason is, that the weight of a pound of any substance, the force with which it is attracted to the earth, is not everywhere the same. Although this does not interfere with its use as a measure of mass, yet it at once prevents its employment as a measure of force. This will be clear if you consider how inconvenient it would be to measure distances with a foot-rule which is sometimes longer and sometimes shorter. Besides this, it will be found, I believe, that by adopting these units we shall be able to express many of our results much more simply than by any other means.

Ambiguous phraseology.

§ 29. We will now turn to some experimental illustrations of the principles that have here been discussed. The apparatus required is very simple, and with a little mechanical skill you will be able to try the experiments for yourself. It is very desirable that you should do so; for this course will enable you to realize what we have been talking about, and may make clear

Atwood's machine.

*They are "equal" forces because they can neutralize each other when placed in opposition, or because they produce the same effect upon a balance, or because they require equal muscular efforts to oppose them. We cannot go back to our definition of the magnitude of a force to help us here, for that implies that we know how to measure mass: on the contrary, we are at liberty to define "equal" forces, and the above is the most convenient way of doing so.

many things that otherwise would be but imperfectly understood.

The first illustrations we shall give will involve the use of a simple contrivance called, after the name of its inventor, Atwood's (or Attwood's) machine. This instrument consists essentially of a pulley, over which passes a cord. To the ends of this cord can be attached different masses (see fig. 15). The stand upon which the pulley is supported is graduated in feet and parts of feet. In experimenting with this instrument we take one of the masses, A say, rather larger than the other. Then A will descend, pulling B up on the other side. If we have a time-measurer we can tell how far A will descend in a certain time, or how long A will take to move through a certain distance; and a little practice will enable us to do this with a considerable approach to accuracy. Moreover, a very ingenious contrivance enables us to measure how fast A is moving at any given portion of its fall. To do this we divide the mass A into two parts. One part, equal to the mass of B, is shown at *a* in fig. 16. The rest is in the shape of a bar (*a'*, fig. 16). In the same figure S is a part of a rod which supports the whole instrument; and upon this rod a ring, R, can be moved up or down, and fixed in any position by means of a screw shown on the right of the figure. We place this ring so that it will allow the mass *a* to pass through it without touching; but will not allow *a'* to pass through. The result is that *a'* is left behind upon the ring, R, while *a* goes on by itself. But *a* contains the same mass as the body (B in fig. 15) on the other side of the pulley; and its own weight pulling it down is exactly neutralized by the weight of the other mass which pulls *a* upwards. The consequence is that it goes on moving neither faster nor slower; and if you mark how far it goes in one second after passing the ring, you will know how fast it was moving just at the moment it came to the ring.

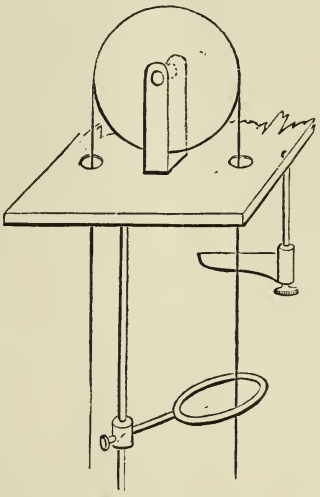
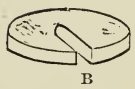


FIG. 17.

A



B

FIG. 18.

The importance of studying mechanics experimentally cannot be too frequently urged; and in the present instance it is especially desirable to see for yourself, not to trust to reading alone. Make an Atwood's machine for yourself. It will not give you much trouble, and it need not cost much. You will have an instrument that will not give you very good results, perhaps; but it will help you to realize the meaning of what we are talking about, and will render your study of this part of the subject full of interest.

Details of Atwood's machine.

The wheel should be about four inches in diameter, as light as possible, and turning very easily. If you can get it mounted upon "friction-wheels," so much the better; but this is not necessary. It is, however, desirable that the axle and bearings should be well turned, as otherwise the friction will be *irregular*. It may be mounted upon a small wooden bracket, as in fig. 17, which is to be fixed at a height of from six to seven feet above the ground. The two openings through which the cord passes act as guards preventing the masses attached to the cord from passing over the pulley.

Passing from the bracket down to the ground there should be a rod upon which are three or four rings (such as chemists use for supporting retorts), which can be clamped at any required height on the rod. It will also be convenient to have the rod marked in feet and tenths of feet. The graduation should begin at the top, or, more correctly, from the point at which the greater mass starts in each experiment.

§ 30. The "weights" may be arranged in any one of several convenient forms. For instance, two may be made in the shape of boxes, each of which will hold several of the others. Or again, two may be made of the form shown at A in fig. 18, the rest being of the form shown at B in the same figure. Either of these is convenient, because it offers an easy means of attaching as many "weights" as you please to each end of the cord. It is not important that your "weights" should be of any specified magnitude; you need not trouble to have them (say) exactly two ounces each; but it is important to have them equal. As to shape of the extra "weights"—that is to say, those which are to be removed during the experiment—there is very little choice. They must be bars or rods which are too long to pass through the rings you have selected; and, of course, they must be equal in mass to the other "weights."

Amongst the different plans of starting an experiment, two may be mentioned. In the first of these, the greater mass is supported upon a hinged flap, and just as the experiment begins, this is allowed to fall, a small wire bolt being removed. Or again, you have an arrangement something like the clasp of a book, the hinge being upright. The mass that is to descend is just supported upon the edge of

this, and the experiment is begun by smartly knocking the support away with your finger. Whatever means you adopt, the points to which special attention should be directed are these: you ought to know the exact instant at which each experiment begins, and you ought to be able to start one at any instant after the preparations are complete.

§ 31. And now as to our time-measurer. If you have at your command a clock or watch that beats seconds, half-seconds, or quarter-seconds, you will want nothing more; but as one cannot always monopolize these useful machines, it is well to have a rough and ready substitute. This is easily provided. Take a fine thread, to one end of which is fastened a small bit of lead or other metal, the other end being fixed so that the whole hangs down and can swing backwards and forwards. The string should be 39 inches long; or more correctly, this should be the distance from the point of suspension to the middle of the mass which forms the "bob." The instrument is then allowed to swing—about three or four inches to each side. Each of these swings will last one second—that is to say, the bob will pass from the left to the right in one second; it will come back to its former position, after completing what De Morgan called a "swing-swang," in two seconds. If the pendulum is required to beat half-seconds, you must make it one *quarter* of the length of the previous one; it must be $9\frac{3}{4}$ inches long. The swing of this pendulum lasts half a second, and of course the swing-swang lasts for one second.

How to measure time.

For many experiments this subdivision of time is not sufficiently minute, and it is very desirable that you should be able, without any other help than that of a pendulum, to divide the second into quarters. A good plan of doing this—a plan which has the advantage of keeping a record of the time that elapses—is that adopted by musicians in "counting bars." We make a slight modification in it, and then our counting runs thus:—NOUGHT, one, two, three, ONE, one, two, three, TWO, one, two, three, THREE, one, and so on. The NOUGHT, ONE, etc., come just at the end of the pendulum swings. A little practice will enable you to manage this without any difficulty, at the same time bringing in the "one, two, three" in each second without hurry or irregularity. Indeed, when you have once got the rhythm you will find that you can count second after second without any need of reference to the pendulum to correct you. It is worth a little trouble to acquire this power, which will be useful in many ways. You will observe from the example above that at the end of the first quarter of each second we say "one," at the end of two quarters "two," at the end of three quarters "three," and at the end of four quarters we give the number of the second that is just ended. The effect of this arrangement is that the number we are naming at any moment always gives the time that has elapsed since the "NOUGHT." For instance, in the example given above the counting lasts for $3\frac{1}{4}$ seconds.

ON GOING TO EXTREMES.

BY THOMAS DUNMAN.

FEW words have been more abused or more misapplied than the word "temperance," a term which nevertheless implies moral qualities of the highest order. To be thoroughly sober and temperate in word and deed, to avoid all violent extremes, and to possess an evenly balanced intellect, are qualities as valuable as they are rare; and these are the necessary qualities of a truly temperate man.

It is a very valuable characteristic of some individuals that they are thoroughly temperate in speech. Yet how few people we find who can be justly held to possess this virtue! In the expression of an opinion, and especially in the defence of it, it would be too much to expect of average humanity if we looked for perfect moderation; but unfortunately the natural tendency to exaggerate which some people exhibit, extends to the narration of the simplest incident which comes under their notice. This tendency should be most carefully guarded against, as it is frequently productive of much mischief, and often seriously warps the moral sense.

We are not speaking now of *wilful* exaggeration, but of the unintentional colouring of an incident through the neglect to duly weigh the language in which thought is clothed. Nevertheless to diverge, even unintentionally, from strict accuracy is to depart from the truth, and this is a practice the reverse of commendable. In defending or attacking an opinion, moderation is not only a matter of duty, but is undoubtedly the best policy. Unmeasured terms rarely convince an opponent, and are apt to degenerate into gross flattery or virulent abuse.

A large amount of unhappiness is caused by the want of moderation in our desires. Of very few indeed in the present age can it be said that they "want but little here below, nor want that little long." With the advance of civilization and education, our artificial wants have largely increased, and a habit of extending our desires far beyond reasonable limits has been engendered. Such a habit requires careful watching, for if unrestrained it may spoil the happiness of a life and greatly mar its usefulness. All that has been written against ambition is by no means true, but it is nevertheless necessary to limit our desires by our talents and opportunities, and to bear in mind that the control of unreasonable desires and expectations implies a far nobler and more manly spirit than to aim solely at their gratification.

The possession of moderate opinions is by no means a universal merit at the present day. Not only in politics, but upon every social question, the tendency is to rush to extremes. Many perfectly laudable objects are aimed at

by the well-intentioned, but in far too many cases the manner in which these objects are advocated is so intemperate that people of moderate opinions speedily become disgusted, and the cause, although good in itself, languishes for want of support. This intemperance frequently results from want of due consideration, and from inability to control natural impulses. To act upon impulse, as so many otherwise estimable persons commonly do, is to court ridicule and defeat. It should be borne in mind that extreme opinions are rarely or never correct, and that truth is nearly always found in the "happy mean" between them. The great want of liberality towards the opinions of others which is unhappily so prevalent is a natural result of the intemperate manner in which opposing views are espoused.

A most unfortunate example of intemperance and want of moderation is frequently seen in the violent likes and dislikes which many individuals exhibit. Every one is acquainted with people who can never speak in measured terms of others; either they are worshipped as idols or hated as demons. This is a weakness from which even great minds are seldom wholly free. Men like Johnson, Macaulay, and Carlyle only too frequently have allowed their antipathies to lead captive their judgment, causing a shadow to fall even upon such brilliant productions as these great minds have bequeathed to those who come after them. When some of the most gifted men the world has produced have exhibited such intemperance in their likes and dislikes, it is perhaps too much to expect ordinary people to be entirely free from this infirmity, yet the sum total of hatred and strife would be immeasurably decreased if it could be so. Some of the most bloodthirsty wars have originated in national antipathies at least as much as in political complications, and in private life disagreement and strife is frequently traceable to intemperate dislike. If the evils due to unreasonable hatred are manifold, still more so are those which can be traced to over-fondness, especially upon the part of parents. An overweening affection for a friend or for a child frequently leads to the utter ruin of the very individual upon whom that affection is lavished, while injustice is at the same time wrought to others at least equally deserving. Most persons have a kind of instinct which leads them to like or dislike a person the first time they make his acquaintance; but far too much stress is laid upon the supposed correctness of this faculty. For once that a first impression of an acquaintance is verified by subsequent experience, it is in many instances found to be entirely fallacious. It is therefore incumbent on all to divest themselves, as far as possible, of unfounded likes or dislikes, and to judge men as well as things entirely upon their own merits. By practising this precept many errors may be avoided and much evil averted.

A direction in which the necessity for temperance cannot be too much insisted upon is in that of self-esteem. Here, too, we must be very careful to fully understand in what true temperance consists. Temperance is not abstinence, except from that which is altogether wrong; and a certain amount of pride is necessary as well as perfectly right. To value oneself too highly is a very natural tendency, but it is by no means unusual to find examples of the opposite extreme. Here, as in other things, we must endeavour to hit the happy mean. While an over-estimate of our importance or abilities is foolish and wrong, to undervalue our talents is to expose ourselves to injustice and oppression at the hands of others, and to allow ourselves to be unfairly vanquished in the race of life. Foolish self-conceit is an odious vice, self-reliance founded upon a just estimate of our own powers a commendable virtue.

Temperance in pride is also of considerable importance. In their eagerness to discourage improper pride many moral censors have altogether denied the necessity for its existence even in a modified form. But this is doubtless an error. The pride of birth which looks scornfully down upon those less fortunately placed is as foolish as it is contemptible; but it is after all only an improper and unpleasant phase of the same sentiment that is embodied in the well-known maxim "*noblesse oblige*." To regard with pride an honourable name, or to scorn to soil a noble escutcheon, are sentiments of the loftiest character; and the pride which glories in an honest name is an ornament to any individual, however humble, as well as a strong incentive to virtue.

It may perhaps seem strange, but it is nevertheless true, that we must observe temperance even in the practice of virtue. However paradoxical it may at first sight appear, a little consideration will, we feel sure, convince any reasonable person that we may have too much of a virtue or of a grace. Amiability carried to extremes would lead to the condoning of the worst offences. Charity, if unrestrained by prudence, degenerates into the encouragement of imposture; and a desire to avoid strife, when carried to unreasonable lengths, ends in the acceptance of the absurd doctrine of non-resistance.

It need hardly be said that there can be no temperance in things which are unlawful; from such total abstinence is alone permissible. But as a very high authority tells us there are things which are "lawful but not expedient," it behoves us to carefully consider the course of action which, in any given circumstances, we intend to adopt, and having assured ourselves that it is lawful, we can then determine as to what extent it may also be expedient.

It is beyond our province here to more than hint at the necessity of temperance in eating and drinking, but it is so obvious that we feel sure there is no necessity to dilate upon it. To keep a clear brain and vigorous physical powers it is absolutely essential that the quality as well as the quantity of the nourishment taken should be such as to fall well within the bounds of true temperance.

Finally, we would specially remind the readers of the UNIVERSAL INSTRUCTOR that there is a necessity for moderation even in the pursuit of knowledge.

BOTANY.

XXXIV.

UMBELLIFERÆ.—CINCHONACEÆ.

ALTHOUGH one of the very large, and in some respects one of the most important of the natural orders, in

The Umbelliferæ.

the Umbelliferæ we have one of the least prepossessing. The species are without exception herbaceous, though in a few cases they attain the brief summer stature of three or four yards. They are very generally of weed-like figure, and although the foliage is often elegant, the flowers are in every instance small and scentless, and usually pale. When the umbels are large, the mass of blossom becomes effective, but the individual corollas are always insignificant. Very curious contrasts are presented in various ways. It is legitimate to base our general idea of the look of the plants here associated upon such as the common hemlock, parsley, fennel, celery, and the carrot and parsnip; for in these is well set forth the predominant complexion of the northern hemisphere species. But on the seashore grows a singular plant, so totally different in features from all the ordinary kinds, that were it not for the minute structure of the flower and fruit, its umbelliferous affinities would never be guessed. This is the common eryngo, or sea-holly, so named from the prickly leaves—a beautiful ornament of the sands, distinguished as plainly by the bright blue heads of flowers as by its prickles. There are some very singular native plants also of the genus Bupleurum, which present scarcely any superficial resemblance to hemlock, but agree exactly in the fructification. The charming garden flower called Astrantia, and various cultivated species of eryngo, not to mention several very lovely curiosities from the antipodes, again illustrate the extreme diversity of the forms of the umbelliferæ. In our own country there is yet another, still more anomalous in general aspect,—the quaint little marsh pennywort, or Fairies' tables, *Hydrocotyle vulgaris*. In the presence of this strange medley it is delightful to be able to fall back upon something that is uniform and changeless,—something that locks the whole company together, and that illustrates perfectly what is meant by the characters of a Natural Order. The absolute marks of the Umbelliferæ are found, as above stated, in the flowers and fruit. The former consist of an irregular pentamerous corolla, seated upon the summit of a two-lobed ovary, the two stigmas of which are fertilized by five stamens. When ripe, the twofold ovary becomes a pair of small, dry, one-seeded fruits, called mericarps, each of the two suspended from the point of one of the prongs of a little erect stalk or peduncle constructed on the plan of the letter Y. Before the mericarps are thrown asunder by the separating of the prongs of the Y, the fruit, as a whole, is called a cremocarp. In one recently discovered New Zealand plant alone is there a solitary mericarp; and even in this case it is not really so, being solitary through the non-development of its partner, the rudiment of which stands alongside.

FIG. 186.—BORAGE.

With this very curious composition of the flower and fruit is usually identified the form of inflorescence called the umbel, either simple or (exclusively in this order) compound, whence the technical name of the family. The umbel may itself be so imperfectly developed, that the three or four little flowers have no peduncles, as in the marsh pennywort; or that the many flowers, much more usual in the order, are consolidated into a head, as in the eryngoes. Far more generally we have either the elegant simple umbel, perfect every way, of the astrantia; or the handsome compound umbel set forth so well in hemlock and fennel. The maximum of dimensions occurs in the huge Siberian cow-parsnip, now common in England, the compound umbel of which measures, not infrequently, from three to five feet across. Very often there is a pretty involucrum of leafy bracts below the umbel, accompanied, at times, by involucels below the umbellules. When coloured, these bracts have quite the semblance of petals, as in the above-named astrantia. Although the order is by no means celebrated for its gay or inviting physiognomy, it thus becomes extremely interesting to the student of delicate vagaries. No other order, indeed, is more practically instructive in regard to unity in variety.

FIG. 187.—HYDROCOTYLE.

FIG. 188.—HOLLY.

The geographical distribution of the species gives to Europe and temperate Asia the greater portion. In England there are plenty, and in early summer none of the wild *white* flowers are more conspicuous than those of the common hedge-parsley, *Anthriscus sylvestris*,

being tossed out in abundance so great that along a hedgerow they seem like the foam of the sea. In North America there are very few; in the tropics none, or scarcely any; in the southern temperate zone, while comparatively few, the species are remarkable in being chiefly anomalous. The beautiful doubly and triply pinnatifid leaves of all the larger British species mingle very agreeably with the grass and other ordinary vegetation of the country.

The properties and qualities of the Umbelliferæ are no less diverse than their figure. At one extreme we have deadly poisons, such as the genuine hemlock, *Conium maculatum*; at the other some excellent vegetables, such as parsley, the carrot and parsnip—which last secrete abundance of sugar, and are therefore profoundly nutritive, as well as wholesome. The interspace is occupied by a multitude of neutrals, though among these are still preserved the traditions of esteem for goodness in the ages passed away. The Angelica, for instance, received its name from the virtues once ascribed to it. Another set of species is distinguished by the production of aromatic fruit. Foremost among these are the well-known caraway, coriander, aniseed, and dill. Another set is distinguished in turn, now very oddly, by the secretion of a considerable quantity of gum-resin, often available for medicinal use. The chief of this last-named group are the asafœtida plant, and the species which yield galbanum and opoponax. The last addition to the list is the sumbul plant, Euryangium Sumbul, which physicians are inclined to regard as an admirable substitute for valerian.

FIG. 189.—CORIANDER.

Little of a properly decorative kind for the flower garden is supplied by the Umbelliferæ. The above-mentioned astrantias and eryngoes cover nearly the whole; though it is always a pleasure to possess one of the stately Ferulas, and to be able to pluck the flowers of the Trachymene, in celestial tint a rival of the bluest of the blue campanulas. White is the ruling flower-colour in the order; a few species have yellow blossoms, and now and then we have pink or lilac.

To behold the Cinchonaceæ in their pride and grandeur, it would be necessary to visit the tropics. the order being one of those which in all its noblest forms is entirely confined to hot countries. Considerable difference of opinion exists as to the proper limits. On the one hand there are the handsome, if not really noble, trees and shrubs with *opposite* leaves; at the other extreme there is a beautiful little group of herbaceous plants, having their leaves in *whorls*, and collectively so different in habit and appearance, that in practice it is thought best by many botanists to keep them apart and give them a name distinctively their own. Adopting this latter course, we have the Cinchonaceæ proper, and the Galiaceæ, the familiar and most numerous species of which belong to the genus Galium. Nearly allied to the last named is the Rubia tinctorum, the plant which yields the dye-stuff called madder; and this one being pre-eminent in its little company, the original name of the entire group, from the cinchona-trees down to the wayside weeds, was *Rubiaceæ*. This name is still employed by the botanists who prefer to regard the whole as one great unity. That they form a great unity is indisputable. Many of the genuine Cinchonaceæ are insignificant herbaceous plants. The species which have the leaves in whorls are, nevertheless, so well marked off, that in ordinary field-botany it is convenient to regard them as a kind of supplement.

The genuine Cinchonaceæ are at once recognized by their opposite, simple, and undivided leaves, with *interpetiolar stipules*; the monopetalous four- or five-lobed corolla, with four or five epipetalous stamens; and the inferior and two-celled ovary. The arborescent forms have their most striking representatives in the Cinchona-trees *ipsissimæ*. The home of these invaluable plants is the great mountain range of the western side of sub-tropical South America, where they constitute extensive forests. Of late years great and successful efforts have been made to cultivate the best of the many kinds upon our East Indian hills; and in course of time it is eminently probable that Great Britain will no longer be constrained to look to the Andes for her supply of quinine, or as it was formerly called, Peruvian bark. Ipecacuanha, another medicine held in high esteem, is obtained from one of the herbaceous species of this order, a plant called Cephaëlis. In hot-houses and conservatories there are many beautiful members of it—Ixoras, Gardenias, Bouvardias, and the Luculia holding the foremost place in the delightful phalanx. Under glass it is common also to meet with the coffee-tree, one of the most illustrious plants in nature, and one in which the family characters are set

The Cinchonaceæ.

forth perfectly. The glossy evergreen foliage, the beautiful star-shaped white flowers, which closely resemble those of the white jessamine, and the bright red berries, which resemble cherries, only that they are oval instead of globular, unite to render the *Coffea Arabica* worthy of a place in every collection that pretends to do more than gratify a taste for mere finery, such as in floriculture corresponds with an uncultured love of ribbons. No plants of this order are sufficiently hardy to live out of doors in England.

The Galiaceæ. The elegant little plants which constitute the sub-order Galiaceæ are, on the contrary, adapted, in every case, to a climate such as our own. In England their most pleasing forms exist in the common yellow or sweet-scented galium, and the common woodruff, *Asperula odorata*, so fragrant when dry, and so inviting in the shady grove, where in May it lifts up its handfuls of little white crosses. Many of the Galiums occur, and in their own proper places, in the hedgerows and by the pond-side, contribute, in no small measure, to the summer ornament of the country.

The Caprifoliaceæ. Remove the interpetiolar stiples, and there is very little left to constitute a valid distinction between the Cinchonads and the trees and shrubs which have their most charming representative in the honeysuckle, *Lonicera Caprifolium*, whence their collective name, Caprifoliaceæ. The order is by no means either extensive or economically important, though it includes many deservedly esteemed decorative plants. It differs, however, so distinctly from the last-described, alike in general appearance and in properties, that it is very properly kept by itself. Familiar representatives occur in the common elder-tree, and the many species of viburnum, including the so-called Gueldres-*rose*. In the wild state, or as occurring in hedges, the cluster of flowers is flat, with a beautiful coronet of greatly dilated barren ones. Under cultivation all the corollas become similarly dilated, and then we have that universal favourite, the snowball-tree. The honeysuckles are not by any means exclusively twining plants. Twining, indeed, as in several other orders, is not the rule, but the exception—a circumstance which should be remembered as putting us upon our guard when disposed to judge too hastily, from a single species, of the complexion and character of the group it belongs to. In our English hedgerows there is nothing lovelier than the woodbine. Milton justly calls it the "well-attired," the idea of attire involving consummate delicacy and grace of finish, thus something far ahead of simple dress. The series of upward steps—if we would employ this and other words of similar sense with the exactitude they deserve is, beginning with clothing, then in successive order, dress, array, apparel, attire; five terms in all, each to be applied in its own distinct and proper way,—*i.e.*, "clothed" in order to become human beings; "dressed" for the promenade; "arrayed" like Solomon; "appareled" like a queen; "attired" like nature's woodbine. Study the habit of the plant, the foliage, the inflorescence, the tints, not forgetting the odour, and you will see why the author of "Comus" gave it the epithet in question in preference to any other. The berries produced by many of the Caprifoliaceæ, if not positively deleterious, are at all events never to be trusted. Now and then, as in the case of the common elder, a kind of medicinal wine can be manufactured from them; others, like the snowberry, are probably innocuous: but, as a rule, it is best to leave them where they grow.

XXVIII.

Practical Application.

(1.) VOCABULARY XVI.

Les fruits et les arbres fruitiers, *Fruits and Fruit-trees.*

abricot, *apricot;*	abricotier.
airelle myrtille *or* mauret, *bilberry;*	do.
amande, *almond;*	amandier.
aveline, *filbert;*	avelinier.
banane, *banana;*	bananier.
brugnon, *nectarine;*	do.
canneberge, *or* airelle des marais, *cranberry;*	do.
cassis, *black currant;*	do.
cerise, *cherry;*	cerisier.
châtaigne *or* marron, *chestnut;*	châtaignier *or* marronnier.
citron, *lemon;*	citronnier.
coco, *cocoa-nut;*	cocotier.
coing, *quince;*	cognassier.
corme *or* sorbe, *service-berry;*	cormier *or* sorbier.
datte, *date;*	dattier.
faîne, *beech-nut;*	hêtre.
figue, *fig;*	figuier.
fraise, *strawberry;*	fraisier.
framboise, *raspberry;*	framboisier.
groseille à grappe, *currant;*	groseillier.
—— à maquereau, *gooseberry;*	—— à maquereau.
gland, *acorn;*	chêne.
limon, *lime;*	limonier,
merise, *wild cherry;*	merisier.
mirabelle, *mirabelle plum;*	do.
mûre, *mulberry;*	mûrier.
—— sauvage, *blackberry;*	—— sauvage.
nèfle, *medlar;*	néflier.
noisette, *hazel-nut;*	noisetier.
noix, *walnut;*	noyer.
olive, *olive:*	olivier.
orange, *orange;*	oranger.
pêche, *peach;*	pêcher.
poire, *pear;*	poirier.
pomme, *apple;*	pommier
—— sauvage, *crab-apple;*	—— sauvage.
prune, *plum;*	prunier.
—— de Damas, *damson;*	do.
prunelle, *sloe;*	prunellier.
raisin, *grapes;*	cep de vigne.
reine-Claude, *greengage;*	do.

In this list all names of fruits ending in *e* and *noix* are fem., all other nouns are masc.

(2.) Conjugation of *recevoir*, model for verbs of the 3rd conjugation.

INFINITIVE.

Present.	*Past.*
recevoir, *to receive.*	avoir reçu, *to have received.*

PARTICIPLE.

Present. recevANT, *receiving.*

Past reçU, *received.* [*ceived.*
ayant reçu, *having re-*

INDICATIVE.

Present.	*Perfect Indefinite.*
je reçOIS, *I receive,*	j'ai reçu, *I have re-*
tu reçOIS *etc.*	tu as reçu [*ceived, etc.*
il reçOIT	il a reçu
nous recevONS	nous avons reçu
vous recevEZ	vous avez reçu
ils reçOIVENT	ils ont reçu

Imperfect.	*I was receiving, etc.*	*Pluperfect.*	*I had received, etc.*
je recevAIS,		j'avais reçu,	
tu recevAIS		tu avais reçu	
il recevAIT		il avait reçu	
nous recevIONS		nous avions reçu	
vous recevIEZ		vous aviez reçu	
ils recevAIENT		ils avaient reçu	

Perfect Definite.	*Perfect Anterior.*	*I had received, etc.*
je reçUS, *I received,*	j'eus reçu,	
tu reçUS *etc.*	tu eus reçu	
il reçUT	il eut reçu	
nous reçÛMES	nous eûmes reçu	
vous reçÛTES	vous eûtes reçu	
ils reçURENT	ils eurent reçu	

Future Absolute.	*I shall receive, etc.*	*Future Anterior.*	*I shall have received, etc.*
je recevRAI,		j'aurai reçu,	
tu recevRAS		tu auras reçu	
il recevRA		il aura reçu	
nous recevRONS		nous aurons reçu	
vous revevREZ		vous aurez reçu	
ils recevRONT		ils auront reçu	

CONDITIONAL.

Present or Future.

je recevRAIS, *I should re-*	nous recevRIONS
tu recevRAIS [*ceive, etc.*	vous recevRIEZ
il recevRAIT	ils recevRAIENT

Past.

j'aurais (eusse) reçu, *I should have received,*
tu aurais (eusses) reçu *etc.*
il aurait (eût) reçu
nous aurions (eussions) reçu
vous auriez (eussiez) reçu
ils auraient (eussent) reçu

IMPERATIVE.

reçOIS, *receive thou.*
qu'il reçOIVE, *let him receive.*
recevONS, *let us receive.*
recevEZ, *receive ye.*
qu'ils reçOIVENT, *let them receive.*

SUBJUNCTIVE.

Present.	*that I may receive, etc.*	*Perfect Definite.*	*that I may have received, etc.*
que je reçOIVE,		que j'aie reçu,	
tu reçOIVES		tu aies reçu	
il reçOIVE		il ait reçu,	
nous recevIONS		nous ayons reçu	
vous recevIEZ		vous ayez reçu	
ils reçOIVENT		ils aient reçu	

Imperfect.	*Pluperfect.*	*that I might have received, etc.*
que je reçUSSE,	que j'eusse reçu,	
tu reçUSSES	tu eusses reçu	
il reçût	il eût reçu	
nous reçUSSIONS	nous eussions reçu	
vous reçUSSIEZ	vous eussiez reçu	
ils reçUSSENT	ils eussent reçu	

(3.) The six verbs conjugated like *recevoir:*

devoir, *to owe.* décevoir, *to disappoint.*
redevoir, *to still owe.* percevoir, *to collect.*
concevoir, *to conceive.* apercevoir, *to perceive.*

(*Remarks.*—1. It is a common mistake on the part of beginners to treat *devoir* as if it were written *devevoir.* Because we say *je reçois,* that is no reason why one should say *je devois;* rec-*evoir* gives reç-*ois,* and thus d-*evoir* gives d-*ois.*—2. The past participle masculine singular is *dû,* to distinguish it from the contracted or partitive article *du;* by analogy the p. part. of *redevoir* is *redû.* Otherwise write *dus, redus, due, redue,* etc.)

EXERCISE XL.

1. They receive apples; they were not receiving any pears; did they receive plums? will they not receive greengages? 2. Thou wilt receive, said (*dit-*) he, twenty-one apricots. 3. You have received nectarines and peaches.—I? never. 4. Here are the fruits: thou wilt receive all (*toutes*) the almonds; she will receive all the filberts; I shall keep (*garderai*) all the chestnuts. 5. I should perceive them; I shall not perceive you; do I perceive her? 6. Who perceives currant bushes and raspberry bushes?—I do.* 7. Who will first (*le premier*) perceive some fruit (*pl.*) on this quince-tree?—He. 8. Do you perceive a medlar-tree among (*parmi*) those hazelnut-trees? 9. We were perceiving from time to time a solitary crabtree (*de temps en temps un —— solitaire*). 10. He owes *to* me; she was owing *to* thee; you owed *to* him; we shall owe *to* her. 11. We *had to* (owed, *perf. def.*) wait (*attendre*). 12. I shall owe my life (*vie, f.*) to him or to her. 13. These date and (these) coco palms owe their vigour (*vigueur*) to my cares (*soins*). 14. He received us under a spreading chestnut-tree (*sous un —— aux rameaux étendus,* or *sous un —— dont les rameaux s'étendaient au loin*). 15. Thou perceivest them under those olive-trees. 16. Your father owes me a large sum (*beaucoup d'argent*) for those cherry and walnut-trees. 17. He perceived us behind the gooseberry bushes. 18. I owe you something.—To me?—Yes. 19. *I wish him to* (je veux, that he may) conceive suspicions (*soupçons*); *I wish he would* (je voudrais, that he might) conceive suspicions. 20. You still owe me twenty francs; Matthew (*Mathieu*) was collecting the taxes (*impôts*); I should not deceive them.

EXERCISE XLI.

1. Y consent-elle enfin? Non, elle n'y
at last
consent pas, elle s'y refuse. 2. Qu'y avez-
objects
vous mis? Je n'y ai rien mis du tout.
put *at all*
3. Allez-vous en Bourgogne cette année? J'y
go *Burgundy*
vais, mais je ne compte pas y faire un long
go *intend* *make*
séjour. 4. On m'a trompé dans cette boutique.
stay *cheated* *shop*
je n'y retournerai plus.—Le marchand "n'avait
return *more* *tradesman* *did not*

* There are two ways of translating such a phrase: either by a solitary pronoun in the disjunctive form, or by a full proposition (in which *en* replaces the noun) put after the disjunctive pronoun: say, therefore, quite abruptly, *moi,* or *moi, j'en aperçois.*

pas l'air" honnête, "il ne fallait pas" vous y fier.
look *you ought not to have* *trusted*
5. J'ai lu et relu cette page, et je n'y trouve
read *read again* *find*
pas de faute. — Il y en a pourtant une.
error [2] *there is* [1] *yet*
6. Vous voyez cette maison-*là*?—Oui.—"Eh
see *house over there*
bien," nous y passerons l'été. 7. Si c'est une
well *spend* *summer* *if it*
lettre de Thérèse que vous "venez de" rece-
that *have just*
voir, ne manquez pas d'y répondre aujourd'hui.
fail *answer* *to-day*
—J'y ai déjà répondu. 8. Monsieur Dupré
est-il chez lui?—Oui, monsieur, il y est; mais
at home
il ne reçoit pas: il est malade. 9. S'ils s'ap-
visitors are not admitted *ill* *ap-*
prochent trop près du bord de la rivière ils y
proach *near* *bank* *river*
tomberont.—S'ils y tombent ils s'en tireront:
fall * *get out*
ils nagent comme des poissons. 10. Est-ce
swim *like* *fishes* *it*
assez, dites-moi; "n'y suis-je point encore"?—
enough *tell* *will this not do yet*
Non.—M'y voici donc?—Pas du tout.—M'y
this will do then *not at all* *that will*
voilà.—Vous n'en approchez point. 11. Com-
do *come near* *how*
bien en offrez-vous?—Je n'en offre rien, car
much *bid* *nothing for*
je n'en ai pas besoin. 12. Voilà des bananes
need *here are*
et des dattes que je viens d'acheter, en voulez-
which (*see p.* 236, v. I.) *buy* *wish to*
vous?—Veuillez m'en donner quelques-unes?
have *be so kind as to* *give* *some*
13. Comment trouvez-vous ces merises? Vous
how *like*
en cèderai-je quelques kilogrammes? — Je
pass *a few*
serai bien aise d'en prendre une demi-douzaine
very glad *take*
de kilogrammes. 14. Où allez-vous?—Moi?
are you going
je vais à la campagne; est-ce que vous en
go *country*
venez?—Non, nous n'en venons pas. 15. Il
come *come*
vous a demandé des airelles, et vous lui en
asked for
avez donné?—Assurément, pourquoi ne lui en
given *of course* *why*
aurais-je pas donné? 16. Avez-vous retenu le
do you remember
texte de sa lettre? Moi, j'en ai retenu l'esprit.
words *contents*
— J'en ai oublié et le texte et l'esprit.
forgotten both
17. Avez-vous rapporté des fleurs du jardin?
brought back *garden*
—Oui, nous en avons rapporté. 18. Ont-ils
lu du français aujourd'hui?—Non, ils n'en
read
ont pas encore lu. Quand en liront-ils?—Ils
when *will read*
en liront demain. 19. A-t-elle une nèfle?—
to-morrow
Non, elle n'en a pas. Oui, elle en a une. 20.
"Qu'a-t-on à" se plaindre de lui (*or* d'elle,
why does one * *complain*
or d'eux, *or* d'elles)?—On ne s'en plaint pas.
* *complain*

* Not to be translated. This is the reflective pronoun, which will be explained in next lesson.

EXERCISE XLII.

(*For each phrase consult the corresponding number in* Ex. XLI.)

1. We consent to it, if * she objects to it.
consentons
2. The cook "has put nothing but" pepper
cuisinière *n' a rien mis que* *poivre*, m.
into it. 3. I "am going" to France this
vais *en*
winter, whether you go (there) or not.
que *alliez* *non*
4. "There is a dishonest look" about that
ce —— n'a pas l'air honnête
tradesman: "do not trust him;" avoid his
ne vous ——fiez pas *évitez*
shop; do not "go back" to it. 5. The master
retournez *maître*
says that he has read this page, and that he
dit qu' *qu'*
does not find any error in it. 6. Try that
n' *trouve* *essayez*
"hotel over there;" I once spent a fortnight
hôtel-là [2] *une fois* [1] *ai passé*
in it. 7. Answer the letter "just received,"
répondez à *qui vient d'arriver*
answer it immediately. 8. Is Mrs. Dupré
sur-le-champ
"at home"? No, sir, she is in the country.—
chez elle *à la campagne*
"How long" "has she been" there?—*For* †
depuis quand *est-elle*
a fortnight. 9. "Do not go near" the river,
ne vous approchez pas de
you might fall into it. 10. This will do, my
pourriez tomber *vous êtes*
friend. 11. How much did you bid for them?
ami *avez* *offert*
12. "Will you let me have" some oranges and
me céderez-vous
lemons if you have more (of them) than you
plus *que*
need (have need of them)? 13. I do not
n' . . . avez besoin
think these grapes good; I "shall only take"
crois que ce *soit bon* *n'...prendrai qu'*
half a dozen of kilos (of them). 14. "Are
you returning" from the country?—*I am* (yes,
revenez-vous
I am returning from it).—Are the roads bad
reviens
there?—"I can vouch for that." 15. As to
ne m'en parlez pas *quant*
strawberries and (to) currants, *if they are asked for* (if they "ask for" any), give *them*
si l'on . . . demande *donnez*
(some of them). 16. I have forgotten the
oublié
words of it, but I remember *its contents* (the
texte, m. *j'... ai retenu*
contents of it). 17. Mulberries! "do bring us"
esprit, s. *apportez-nous-...donc*
a small plateful (of them). 18. Ask *her* (to
(*see Voc. XV.*) *demandez*
her) if she read any Italian to-day. Ask *him*
a lu (*see Voc. XIV.*)
(to him) "if he" read any. 19. If I get a
s'il *reçois*
handful of acorns, will she get one too?
(*see Voc. XV.*) (*of them will she receive one also*)
20. "They are complaining" of him ‡ and of us.
on se plaint

* *Si* is not elided before *elle*; it is so before *il* and *ils* only.

† Not to be translated.

‡ As there are two objects to the verb, the pronoun takes the disjunctive form, and the preposition is literally translated, both appearing after the verb. Compare 3 *b*, p. 199.

XXXIII.

The Adverb.

§ 204. Derivation of adverbs.
§ 205. From *Nouns:* (*a*) genitive case, (*b*) dative, (*c*) accusative.
§ 206. From *Adjectives:* (*a*) old ending in *e*, (*b*) ending in *lice* or *ly*.
§ 207. From *Pronouns:* (*a*) Adverbial conjunctions, (*b*) Adverbs of negation and affirmation.
§ 208. From *Prepositions:* (*a*) Composite adverbs (*b*) Prepositional phrases.
§ 209. Other compound adverbs.
§ 210. Comparison of adverbs.

The adverb, as was shown in § 89, modifies or qualifies the verb, or it adds force or description to an adjective or another adverb; some adverbs have also much importance in joining sentences together.

§ 204. Some of these words are always adverbs and nothing else, such as *here, there, once, yesterday;* others are nouns, adjectives, or prepositions used in the position of adverbs. That this is able to be done now helps to explain how it is that many words recognized as adverbs proper were formerly nouns or adjectives in different cases, or pronouns or adjectives with additions. Adverbs, then, have no inflexions proper to themselves, except in some instances of comparison which are formed upon the model of adjectives. The classification before given was according to *meaning;* it is useful to study this large and miscellaneous set of words according to their *derivation*, or origin, in order the better to understand their true meaning.

We have, then, instances of adverbs derived as follows :—

§ 205. (1) From **Cases of Nouns** and numeral adjectives. (*a*) in the genitive case: *needs* (*i.e.* of necessity), *noways, sideways, always* (*algates* in Old English), *now-a-days, o'nights, betimes, sometimes, else* (O. E. *elles*), *eftsoons, afterwards, towards, whiles, unawares, once, twice, thrice.* Ex.: "And stooping down as *needs* he must" (Cowper, *John Gilpin*); "Such as sleep *o'nights*" (*Jul. Cæsar*, Act i. sc. 2); We hear no such music *now-a-days*—that is, *now of a day.* The *s* is the relic of the old genitive ending of the noun, *es* (see before, § 154); it was an idiom of Old English to employ certain nouns in the genitive case adverbially, as it is still in German (Er ging *eines Tages* zur Stadt, he went of a day (i.e. *one day*) to town). We have the remains of the custom on the lips of the vulgar: "I does my washing *of a Monday*"; "she only gets out *of a Sunday.*" In "go out *of doors*" we appear to have the double genitive, though in "she is in *doors*" the older form subsists. So also in "he went up *stairs.*" In Middle English *once, twice,* and *thrice,* had the forms *anes, ans,* or *ones, twies,* and *thries*; the Scotch still have *ance.* Our present *against, amongst, whilst, amidst,* and *betwixt,* too, are but altered forms of the Middle English genitives *againes, amonges, whiles, amiddes, betwix* (the words themselves, except *whiles,* being originally compound prepositions used as adverbs: see after, § 208).

(*b*) Arising from the old dative case we have *whilom* (from the noun *while,* time), and *seldom* (from the adjective *seld,* rare); *piece-meal* has dropt its former dative ending *um. Sidelong, headlong, darkling,* are remains of old dative nouns. Some words of this kind in the fourteenth century took the genitive ending *es* and *s,* such as *needlings,* meaning needs; and the Scotch still preserve in use *aiblins, hafflins* (perhaps, half), etc.

> "Ye *aiblins* might—I dinna ken—
> Still hae a stake."
> Burns, *Address to the Deil.*
>
> "While Jenny *hafflins* is afraid to speak."
> *Ib., Cotter's Saturday Night.*

(*c*) From nouns, etc., in the accusative case, we have many compound adverbs, such as *straightway, alway,* and others formed with *wise, while, deal, time, day, ward;* as *thuswise, erewhile, somedeal, sometime, yesterday, yesternight, inward, toward.* In such sentences as "they go *home,*" "he rode *east,*" "she goes *north,*" *home, east,* and *north* are accusative forms used as adverbs.

We can say "lay the sticks *crossways,*" and "cut the cloth *cross-wise,*"—indeed, one termination may often be used for the other (though not in *otherwise*),—but *wise* is not another form or a corruption of *ways;* wise is the Old English *wise* = a manner, ways is Old English *weg,* (*weges,* gen.) = a way. *Some-deal* means *partly:* of Samson it is said, "*Somdel* waxen was his here" (*i.e.* his hair was partly grown). (*Cursor Mundi,* l. 7257.)

§ 206. (2.) From **Adjectives.** (*a*) Besides all these there was also a recognized form in the Old English for adverbs converted from adjectives by the addition of *e;* other adjectives ending in a weak *e* were used adverbially—as *yfele,* evil, ill; *efne,* even; *mycele,* much; *lytle,* little; *smale,* small; in both cases the final *e,* not being strongly accented, in time dropped out of use, and the words became again confounded with adjectives. Thus it is that we find such usages as "she speaks *small*" (*Merry Wives of Windsor,* Act i. sc. 1); "Singing so *sweet* and *clear* and *loud*" (Longfellow); Speak him *fair,* The child sleeps as *sound* as a top, This apple tastes *sweet,* "we fought them for *full* four hours," "'tis *all* in vain," "you do *ill* to curse me," "we drink of the *full* flowing bowl," "how *swift* the hours did pass away," "she is *half* afraid." In all these instances the identical words are adverbs, attributive to verb or adjective, which in another construction would be adjectives, attributive to noun.

(*b*) A large number of adjectives were formerly compounded with *lic* (meaning *like*); these becoming adverbs took the *e—lice, liche*—and from these we have the greater part of our present adverbs, those which end in *ly,* the weak *e* dropping off with time, as before shown. So numerous are the adverbs of this class, that the termination *ly* has become recognized as proper to adverbs, and is used in the formation

of new ones. Custom or chance have, however, reserved a few (there are said to be about fourteen or sixteen of them) of the old adjectives of this class, which though they end in *ly* have never become adverbs; such as a *shapely* youth, a *manly* heart, a *goodly* tree, "oft in the *stilly* night." Thus, too, it is explained that in several instances the adverb and adjective are alike, the distinction now being lost: an *only* child (adj.), "I *only* wish to live" (adv.), "all that live *godly*" (2 Tim. iii. 12).

In forming adverbs upon adjectives we must notice that the addition of *ly* causes a few changes in spelling. The adjective whose stem ends in *ue*, loses the *e*, as due, *duly*

„ „ *ble*, loses the *e* and one *l*, as able, *ably*

„ „ *ll*, loses one *l*, as full, *fully*

„ „ weak *y*, changes it to *i*, as happy, *happily*; lovely, *lovelily*

§ 207. (3) From **Pronouns**. From *who*, *he*, and *the* are formed several adverbs, which still preserve some of their relative and demonstrative force;

Who has given rise to *where*, *whither*, *whence*, *when*, *how*, *why*
The to *there*, *thither*, *thence*, *then*, *thus*
He to *here*, *hither*, *hence*

The termination *re* or *er* denoted place—whi-*ther*, thi-*ther*, hi-*ther* being compounds; *en* denoted motion or consequence, *ce* being a genitive ending, as in once, whence, thence, hence, *from* or *of one*, *when*, etc.; these also possess a sense of time; compare the meaning of the words in the following: "the date *whence* that lease begins," "I am blind, *hence* I cannot see," "*Hence-forward* there was great darkness." In "*Hence!* away! now all is well" (*Mid. Night's Dream*, Act II. sc. ii. l. 25) place only is intended.

The old form of then was *than*, which continued till quite the middle of the seventeenth century; *then* is but a recent spelling.

Why and *how* are on the same border line as the interrogative and relative *who* (see before, § 163); we use them in questions, as, *Why* do you weep? *How* do you do? and they also occur as adverbial conjunctions, in "I cannot tell *why* you have spoken"; "show me *how* you tie it." *How* is the old ablative case of *who*.

In the Middle English we had the compounds *for-why*, *for-thy*, meaning wherefore and therefore. *Joseph*, complaining of the dark, in an old miracle-play of the fifteenth century, says: "I will go gete us light *forthy*."

(*a*) It is this class, formed from pronouns, which are used in joining complex sentences, and are hence called adverbial conjunctions, (see § 93). Sometimes the demonstrative is required to complete the sense of the relative, as:

"*When* icicles hang by the wall, etc.
"*Then* nightly sings the hooting owl."
"*Where* the bee sucks *there* lurk I."—*Tempest.*
"*Where* there is a will *there* is a way" (old proverb), or as our fathers would have said with more force, "*Where* is a will *there* is a way."

(*b*) This is the place for the adverbs of negation and affirmation: the formation of *not* from an indefinite pronoun was shown before, § 165 (*e*); *nay* = not ever, from *ne*, *aye*, aye being another form of the adverb *ever*:

"And *aye* she let the tears down fa'
For Jock o'Hazeldean." (Ballad.)

No is from *ne*, one (before, § 165) (*b*); *now*, as well as the conjunction *nor*, also contains the negative *ne*, which is often called a *particle* of speech (little part). *Ne* attached itself freely in the older language where the sense of negation was desired, and was besides often used in its own right; we get thus the compound *nas* for ne was = was not:

"I *nas* neuer ȝet so hardi"
(I was not never yet so bold).
WILLIAM OF PALERNE, A.D. 1350.

"*Nas* neuere swich another as is she,"
(There was not never such another as she).
CHAUCER, *Man of Law's Tale*, l. 159.

The free use of the *ne* led to double and even triple negations, for the sake of emphasis; thus Chaucer has "he *ne* was *nought* gay" (Prologue, l. 74).

'But he *ne* lefte *nought* for rayn *ne* thunder"
(He was not afraid of rain nor thunder).
Ib. 492, MORRIS, *Lessons*, p. 192).

"*Nor* to *no* wight that spark of pitie knew"
Ferrex and Porrex, A.D. 1565.

In the second we have *ne* as *not* and *nor*, besides the compound *nought* = nothing. The modern rule which says "two negatives make an affirmative" was not thought of by our fathers, who cared for emphatic expression more than logic; their usage remains still among the common people, one of whom the writer has just heard say "I do*n't* eat *nothing* some days."

Yea, *yes*, and *yet* contain a demonstrative element like that in the word *yon* (before, § 74): *yea* has gone through several forms, as *ya*, *yha*; *aye* or *ay* = ever, is but another shape of the same, still occasionally in use in the affirmative sense; in Elizabethan times it was spelt as it is pronounced, with the letter I.

§ 208. (4) **Prepositions** enter into the composition (*a*) of some adverbs, (*b*) of certain phrases or expressions used in place of adverbs; the compounds were originally similar expressions of separate words.

(*a*) The principal of these are:—

*Af*terwards, after (both come from *aft*, after being comparative).
*Be*fore, besides, betimes, behind, but (be-out), beneath, because (*be* = *by*).
*For*th, forthwith, forward (forthward), a-fore (further, comparative).
*In*ward, within, indeed, anon (from *in-one* = at once).
Be*neath*, under*neath*.
*On*ward.
*A*jar, *a*sleep, abed, aloft, aboard, aloud (in these *a* represents *on* of Middle English—*on sleep*, *on loft*; we still say *on board*).
*To*wards, to-day, to-night, to-gether.
*Per*chance, perhaps (*per* Romance for *by*).

*Through*ly, thoroughly.
With*out*, ab*out*.
*Up*wards, upper, uppermost.
Too.

Many of these words are also prepositions proper: remember that when there is no noun in the sentence, it is an adverb belonging to the verb—e.g., *he looks upwards*; when there is a noun to be governed, it is a preposition—*she goes without dinner*. It is the same with several other simple prepositions, as *down*, *out*, *off*, *up*, etc. See before, § 96.

But, commonly a conjunction, is adverb in the following:—I can *but* say it is well; She is *but* two years old; where it modifies the verb.

Ago is not formed, like the above words, from the preposition *on*, but is shortened from *agone*, the passive participle of an old verb *agan*, to go by, to elapse: it is now used as an adverb: A long time *ago*; She came to me four days *ago;* but the sense of the verb is evidently in it.

(*b*) Some of the prepositional phrases used as adverbs are:—

To and fro.
Fore and aft.
Hard by, by-and-by, by night, by day, by hundreds, etc.
At length, at last, at night, at best, at large, at random, etc.
Of yore, of old, of new (corrupted into a-new).

§ 209. There are also a few miscellaneous compound adverbs, such as *here-with*, *here-to*, *here-of*, *there-on*, *there-of*, *there-to*, *there-fore*, *there-by* (adv. and prep.); *where-ever*, *where-soever*, *eft-soons* (oft *and* soon), *some-where*, *no-where*, etc. (two adverbs, or adverb and pronoun).

§ 210. **Comparison of Adverbs.**

Beside the formation with *ly*, inflexion remains with adverbs in their comparison. This follows the rule of adjectives, *er* for the comparative, *est* for the superlative degrees of words of one syllable, *more* and *most* for words of more than one syllable, with a few exceptions.

Positive	loud	sweetly	early	(exc.)
Comparative	louder	more sweetly	earlier	
Superlative	loudest	most sweetly	earliest	

In old writers and in poetry occasionally such forms as *gladlier*, *rightlier*, *highliest* occur, but they are not frequent.

Rather is the comparative of the adjective *rathe*, and is now only used adverbially: I had *rather* do it, meaning I had sooner, *i.e.* I *prefer* to do it. *Ere* (old form *are*) is a comparative, with the superlative *erst*, of which now the positive is lost.

"Talde I the lange *are*" (I told thee long before). *York Mir. Plays*, 1450.

"*Erst* the nightingale sang not, but once in a grove" (Toulmin Smith, translation).

We have also the compound *ere-while*.

The student who now recognizes how diverse is the origin of the adverb will understand that the adverbs of *irregular comparison* are to be found among the adjectives and prepositional words which stand on the debateable line, like soldiers who may fight, now on behalf of verbs, now of nouns. For the examples see before, § 170 (3).

XXX.

PERSIA.

THE early history of Persia is shrouded in the mists of remote antiquity, and very little is known to us but what we learn from the works of Firdusi, the Homer of Persia, supplemented by cuneiform inscriptions and Grecian writers.

From these various sources we gather that the districts around Mount Ararat were at one time peopled by the descendants of Shem, and governed by a king named Kaiomars, said to be Noah's grandson, and by some to be Noah himself. His rule being wise and beneficial, the neighbouring tribes constituted themselves his subjects, and they spread eastwards to the plains of Khorassan. The kingdom would appear to have been divided, and to have formed the two countries of Media and Persia. Kaiomars founded the Paishdadian dynasty, that of the earliest known rulers in Persia; but it is so remote and obscured by antiquity that it is probable the distorted accounts extant of the period are for the most part mythical. Constant quarrels and struggles took place between the Medes and Persians, although both formed part of one empire during this dynasty.

First known king of Persia.

The accounts of subsequent monarchs of the Paishdadian line are extremely fragmentary, and so interwoven with romance and fable that they read like stories from the "Arabian Nights." At length the Median empire fell under Assyrian rule, encountering B.C. 880 a great Assyrian king, whose history exists in cuneiform on a black obelisk, and has been deciphered. From this time until B.C. 710 the history of the nation is one of fruitless struggles against the Assyrian yoke; it formed part of the great Assyrian empire, and continued to do so until Cyrus arose, who shook off the foreign rule and made the country independent.

Media conquered by Assyria.

Cyrus was a great and good prince, and mighty in battle. Among his conquests were Syria and Asia Minor; he then annexed his kingdom to Persia, and founded the Persian empire, which stretched from the Indus and the Oxus, on the east, to the Mediterranean on the west. One of the great feats of Cyrus was his conquest of Babylon. Isaiah wrote concerning this king (see chap. xliv. 28). The wicked and sensual Cambyses succeeded Cyrus; he subdued Egypt, reducing it to the state of a colony; he also conquered a great part of Northern Africa.

Cyrus.

Darius is the next important monarch. He was distinguished for his legislative powers as well as for his warlike expeditions. He divided the country into nineteen satrapies, each ruled over by a satrap, or viceroy, with the delegated

Darius.

authority of the king. Zoroaster, the great religious reformer, flourished in this reign, and founded the Magian religion, which acknowledges two great principles—the All-good, called Ormuzd, and an evil being called Ahriman. They are symbolized by light and darkness. True believers were instructed so to conduct themselves that after their death they might be eternally happy with the All-good. In the contrary case they went to dwell in the Kingdom of Darkness. Zoroaster wrote the Zend-avesta, the sacred Book of Laws of Persia. Darius took an interest in the fine arts; he enlarged the famous palace of Persepolis, a most exquisitely beautiful edifice, enriched with precious and delicate carvings. The face of the mountain behind this palace was also adorned with graceful sculptures. The youth of Persia in this reign, says Herodotus, were taught three things—to ride, to use a bow, and to speak the truth. Darius, like Cyrus, is

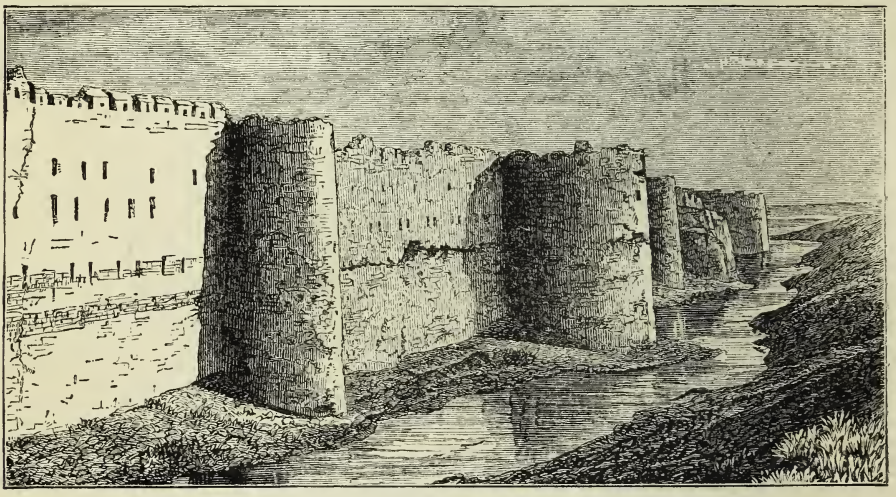
Zoroaster.

encouraged by the defeat of Persia, had taken that opportunity of revolting from her yoke. Resolving to annihilate the Greeks, he equipped an armament said to have amounted to three millions of troops!—an impossible number, of course—and with this vast force intended to crush the Greeks at one blow. He met, however, a serious check at the famous pass of Thermopylæ, which was defended by 400 gallant Spartans against his whole army, and only taken by him with immense sacrifice of men. He was finally completely overthrown, fleet and army too, at the several battles of Salamis, Platæa, and Mycale, escaping with difficulty himself in a fishing-boat. Enraged at his defeats, he became very cruel to his subjects, who at last murdered him, after a reign of twenty-one years.

Xerxes.

Thermopylæ.

His grandson and successor, Artaxerxes, "the Long-hands" of the Persian historians, is celebrated for his intelligence as a legislator,



WALL AND MOAT OF BAGDAD.

mentioned in Scripture as believing in and protecting the Jews (see Ezra vi. 12). His wars and conquests were considerable; he crossed the Thracian Bosphorus into Europe with 700,000 troops, but was repulsed by the Scythian tribes between the Danube and the Don. He next overran and subdued the Thracian and Macedonian territories; then, invading the countries to the east of Persia with a powerful army, he conquered some of those bordering on the Indus, which he converted into a twentieth satrapy, under the name of India. Attempting to crush the rising Grecian communities, his army, though far outnumbering the Greek forces under Miltiades, was completely vanquished on the plains of Marathon, 490 B.C. Darius soon after died, and was succeeded by Xerxes, B.C. 486.

Wars of Darius.

Marathon.

Xerxes quelled the rebellion in Egypt, which, and his beneficent rule. He is supposed to have been the Ahasuerus of Scripture, and it is certain that he treated the Jews with great leniency. His successors, who reigned but for a short time, were Xerxes II. and Darius II.; the latter was followed by Artaxerxes Mnemon, his eldest son, who had to contend with his younger brother Cyrus for the succession. It was in this reign that the famous Retreat of the Ten Thousand, described by Xenophon, took place. Artaxerxes' reign was a scene of intrigue and confusion, and in it symptoms of decay became visible, which were finally to result in the overthrow of the kingdom. Two kings named Darius now followed, the second of whom assumed the reins of government B.C. 336.

Ahasuerus.

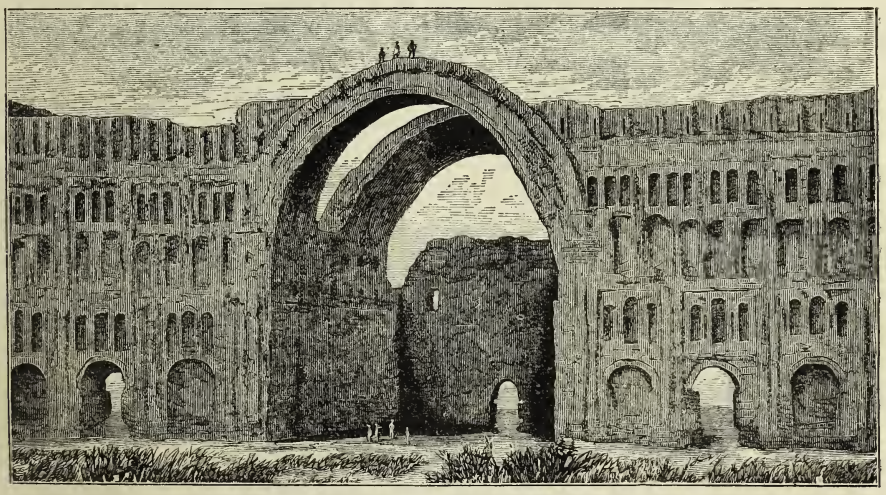
Alexander of Macedonia, having subdued and consolidated the Greek principalities, now invaded Persia, crossing the Hellespont B.C. 334, with a well-trained army of 35,000 men, with

which he encountered the Persians, completely routing their forces on the banks of the Granicus. Persia was speedily again vanquished in the fatal battle of Issus, where, it is said, 100,000 were slain, and the royal family fell into Alexander's hands. The battle of Arbela now completed Alexander's triumph; and Darius, flying from the field, was seized by his own nobles, at the head of whom was Bessus. They bound him in golden chains, and were conveying him on a chariot covered with skins to Bactriana, but being overtaken by Alexander, they stabbed Darius to the heart, and left him weltering in his blood.

Alexander the Great.

Battle of Arbela.

Persia, being now completely subdued by Alexander, became a Greek province until the death of Alexander, B.C. 323, when his great general Seleucus Nicator took possession of the country, and founded the dynasty of the Seleucidæ. He was assassinated B.C. 280,



ARCH AT CTESIPHON, THE ANCIENT CAPITAL OF PARTHIA.

and as his successors were too weak to retain possession of the country, Persia fell under Parthian dominion. The first Parthian king of Persia was Arsaces, who founded the dynasty of the Arsacidæ, which consisted of thirty kings. The first war with Rome took place during this dynasty, B.C. 53, and greatly to the astonishment of the Romans, they were defeated. In B.C. 36, under Marc Antony, the Romans again retired before the Persian arms. These wars weakened the Parthians, and the Persians, ripe for rebellion, revolted under Artaxerxes (Ardeshi), a shepherd's son, who, after a desperate and decisive battle, was hailed king-of-kings, a title ever since retained by Persian rulers. He founded the Sassanian dynasty, and restored the old Magian religion. He was a wise legislator and beneficent ruler. The most distant parts of his kingdom were visited by him, and all wrong-doers were severely punished. His policy was the aggrandizement of

Parthian rule.

Sassanian dynasty.

Persia, and as a means to this end he sent an embassy to Alexander Severus, commanding the Romans to evacuate Asia. This naturally led to a war, which terminated badly for the Persians.

Artaxerxes died 242, and was succeeded by Sapor (Shápur), his son, who continued his father's policy. He carried on war with Rome, and got possession of Armenia. Valerian, emperor of Rome, startled by the audacity of Sapor, himself marched to the frontier to check the Persians' further advance; but was taken prisoner by Sapor, by a base stratagem and betrayal of confidence. The Roman chroniclers say that the emperor was treated with much indignity, but there is no evidence of this in the sculptures at Naksh-i-Réjab, which portray the whole transaction. Valerian died soon after in captivity. Sapor crossed the Euphrates,

Roman Emperor Valerian captured by Persians.

and took Antioch, Tarsus, and Cæsarea. The Romans, under Aurelian, retrieved their credit somewhat at the latter end of Sapor's reign. Although so devoted to war, Sapor conducted useful public works and founded several cities.

The next considerable Persian monarch was Narses (Nersehi), who at once engaged in contests with the Romans, and defeated them signally on the Mesopotamian plains, under Galerius. The emperor Diocletian was enraged by this disgrace. Another battle took place next year, when Galerius retrieved his credit, the Persians being completely routed. Peace was concluded at the price of five provinces, which were ceded to Rome; and the Armenian king was restored to his throne. Rome and Persia were now at peace for forty years, during which time the latter country, freed from the constant drain of war, extended and improved its own resources.

Roman victory.

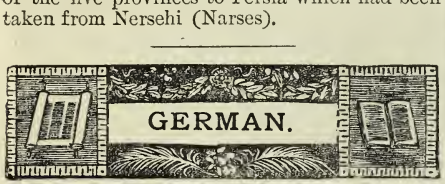
Sapor II., called the Great, was the grandson of Narses. He had a long minority, during which time Arab and other forces invaded

Persia, ill-treating the outlying population. Sapor pursued them, and dislocated the shoulders of all the Arabs he caught, and was hence called "Lord of the Shoulders." Persia engaged in nine battles with Rome during his reign, in some of them successfully. Peace was at last concluded, and it lasted until the accession of the emperor Julian to the Roman throne. However, determining to impress the audacious Persians with the power of Rome, Julian marched on their country, spreading devastation as he went. He reached Ctesiphon, the Persian, capital and defeated their forces outside the city. He decided not to besiege Ctesiphon; but before he had withdrawn his forces a Persian noble came into his camp, pretending to be a deserter from his own side, but in reality to betray the Romans, which he did effectually by persuading Julian to destroy his fleet. This done, the Roman retreat was cut off. Sapor now harassed the Romans, who retreated before him, defending themselves bravely, Julian in particular having the courage of a lion. He was killed, however, and though the Persian losses were great, the advantage was on their side. Jovian, the chief of the late emperor's household, a man much beloved by the army, was elected as his successor. The Roman retreat continued, and terms of peace were dictated by Sapor. The negotiations resulted in the cession of the five provinces to Persia which had been taken from Nersehi (Narses).

Sapor the Great.

Romans in Persia.

Roman retrea.



XXXV.

STUDY FOR READING AND PRONUNCIATION.

„Bei[1] allem, was du thuſt, bedenke das
by al'-lem vass doo toost be-den'-ke dass
"In all that thou dost consider the
Ende." Ein Tataren-chan ritt auf die
en'-de ine tah-tah'-ren-kahn ritt owff dee
end." A Tartar khan rode to the
Jagd. Unterwegs[2], begegnete[3] ihm ein
yaacht un-ter-vaigs be-gay'-gne-te eem ine
chase. On the way encountered him a
Derwiſch, der mit lauter Stimme rief:
dare-vish dare mit low'-terr stim'-me reef
Dervish, who with loud voice cried:
„Wer[4] mir hundert Goldſtücke gibt,
vairr meerr hun'-dert goldt'-stue-ke gibt
"Who to me (a) hundred gold pieces gives,
dem will ich einen guten Rath geben.
dame vill ich i'-nen goot'-en raht gay'-ben
to him will I a good counsel give.
Das Gefolge[5] des Chans lachte und
dass ge'-fol'-ge dess kahns lach'-te unt
The following of the khan laughed and
ſagte der Derwiſch werde wohl
zaach'-te dare dare'-vish vairr'-de vole
said the Dervish would well

wenige Liebhaber[1] für ſeinen guten
vay'-ni-che leep'-hah-ber fuerr zy'-nen goot'-en
few customers for this good
Rath finden. Der Chan jedoch[7] befahl
raht fin'-den dare kahn yay-doch' be-fahl'
counsel find. The khan however ordered
ſeinem Diener dem die Börſe an-
zy'-nem dee'-nerr dame dee boer'-ze an-
his servant to whom the purse en-
vertraut[8] war, dem Derwiſche hundert
fer-trowt' vahr dame dare'-vish hun'-dert
trusted was to the Dervish a hundred
Goldſtücke aus zu bezahlen,[9] und
goldt'-stue-ke owss' tsoo be-tsah'-len unt
gold pieces out to pay, and
dieſer ſprach dann mit warnender[10]
dee'-zerr spraach dann mit vahr'-nen-derr
this (man) spoke then with warning
Stimme: „Bei allem was du thuſt, bedenke
stim'-me by al'-lem vass doo toost be-den'-ke
voice: "In all that thou dost consider
das Ende!" Das Gefolge des Chans
dass en'-de dass ge-foll'-ge dess kahns
the end." The following of the khan
meinte, dieſer gute Rath ſei[11] eine ſo
mine'-te dee'-zer goo'-te raht zy i'-ne zo
thought, this good counsel was a so (well)
bekannte Sache,[12] daß ſie jedermann
be-kann'-te za'-che dass zee yay'-der-mann
known thing that it everyone
wiſſe; aber der Chan ſagte: „Gerade[13]
vis'-se ah'-berr dare kahn zaach'-te ge-rah'-de
knew; but the khan said: "Just
deßwegen denkt man am wenigſten
dess'-vay-gen denkt mann am vay'-nich-sten
therefore thinks one the least
daran, und das iſt wohl der Grund
dah-rann' unt dass ist vole dare grunt
thereon, and that is well the ground
warum der Derwiſch mich an dieſe
vah-rum' dare dare'-vish mich an dee'-ze
why the Dervish me of this
Lebensregel[14] erinnert hat." Als er
lay'-bens-ray'-gel er-inn'-ert hat als airr
life-rule reminded has." When he
von der Jagd heimgekehrt[15] war, befahl
fon dare yaacht hime'-ge-kayrt var be-fahl'
from the chase returned was, ordered
er, daß die Worte: „Bei allem, was du
airr dass dee vorr'-te by al'-lem vass doo
he, that the words: "In all that thou
thuſt, bedenke das Ende!" an die Thüren
toost be-den'-ke dass en'-de an dee tue'-ren
dost, consider the end!" on the doors
und Wände ſeines Palaſtes angeſchrieben
unt vennt'-de zy'-nes pah-las'-tes an'-ge-shree'-ben
and walls of his palace written up
wurden; ebenſo ließ er ſie auch in
voorr'-den ay'-ben-zo leess ayrr zee ouch in
were; even so let he them also in
alle goldenen und ſilbernen Gefäße[16]
al'-le gol'-de-nen unt zil'-ber-nen ge-fays'-se
all golden and silver vessels
eingraben. Nach längerer[17] Zeit faßte
ine'-grah-ben nach leng'-er-er tsite fass'-te
be engraved. After some time took

ein Statthalter[18] den Entschluß, den Chan
ine statt'-halt-er dane ent-shluss' dane kahn
a governor the resolution the khan
aus dem Wege zu räumen[19] und sich
owss dame vay'-ge tsoo roy'-men unt sich
out of the way to clear and him-
selbst zum[20] Herrscher zu machen. Er
zelbst tsum herr'-sher tsoo ma'-chen ayr
self (to) the ruler to make. He
gewann den Leibarzt des Chans
ge-vann' dane libe'-artst des kahns
won the body-physician of the khan
mit einer großen Summe Geldes, so daß
mitt i'-ner gross'-en zum'-me geld'-es zo dass
with a great sum of money so that
dieser versprach, den Chan bei einem
dee'-zer fer-sprach' dane khan by i'-nem
this one promised, the khan at a
Aderlasse[21] zu vergiften. Die Gele-
ah'-der-las'-se tsoo fer-gift'-en dee ge-lay'-
bleeding to poison. The oppor-
genheit[22] fand sich bald; als der Chan
gen-hite' fand sich bald als dare kahn
tunity offered itself soon; when the khan
von einem Unwohlsein[23] befallen wurde,
fon i'-nem un'-vole-zine be-fal'-len voor'-de
by an indisposition attacked was,
verlangte er daß der Arzt ihm
fer-lang'-te ayrr dass dare artst eem
demanded he that the physician him
Ader lasse. Dieser nahm eine vergiftete
ah'-derr las'-se dee'-zer nahm i'-ne fer-gift'-e-te
a vein opened. This one took a poisoned
Lanzette; als aber ein silbernes Becken
lan-tset'-te als ah'-ber ine zil'-ber-nes beck'-en
lancet; when however a silver basin
zum Auffangen[24] des Blutes hingehalten
tsum owf'-fang-en des bloot'-es hin'-ge-halt'-en
for the taking up of the blood forth held
wurde, las er darauf die Worte: „Bei
voor'-de lahs airr dar-owf' dee vor'-te by
was read he thereon the words: "In
allem, was du thust, bedenke das Ende!"
al'-lem vass doo toost be-denk'-e dass en'-de
all that thou dost, consider the end!"
Er erschrack, zögerte einige Augenblicke,[25]
ayrr er-shrahk' tsö'-ge-rer-te i'-ni-ge ow'-gen-blik'-ke
He was alarmed, hesitated a few moments,
legte die vergiftete Lanzette weg und
layg'-te dee fer-gift'-e-te lan-tset'-te vegh unt
laid the poisoned lancet away, and
nahm eine andere. Dem Chan war dies
nahm i'-ne an'-de-re dame kahn vahr deess
took another. The khan was (at) this
aufgefallen,[25] und er fragte den
owf'-ge-fal'-len unt ayrr frahgh'-te dane
struck, and he asked the
Arzt, warum er die erste Lanzette
artst vah-rum ayrr dee err'-ste lan-tset'-te
physician why he the first lancet
weggelegt habe. Der Arzt ant-
veck'-ge-laycht hah'-be dare artst ant-
away laid had. The physician an-
wortete sichtbar verlegen, sie habe
vor-te-te zicht'-bar fer-lay'-gen zee hah'-be
swered, visibly embarrassed, it had
eine stumpfe[27] Spitze. Der Chan ließ
i'-ne stump'-fe shpit'-se dare kahn leess
a blunt point. The khan caused
sich dieselbe zeigen; er sah
sich dee-zel'-be tsy'-gen ayrr zah
to himself the same to be shown; he saw
daß sie scharf genug war, sprang auf
dass zee sharrf ge-nooch' vahr sprang owf
that it sharp enough was, sprang up
und sagte zu dem Arzte: „Nur ein
unt zaach'-te tsoo dame arts'-te noor ine
and said to the physician: "Only an
offenes Geständniß[28] rettet dich vom
of'-fe-nes ge-stennd-niss ret'-tet dich fom
open confession saves thee from
Tode; deine Angstlichkeit macht dich
toh'-de dy'-ne engst'-lich-kite macht dich
death; thy terror makes thee
verdächtig."[29] Der Arzt fiel ihm zu
fer-dech'-tich dare artst feel eem tsoo
suspicious." The physician fell at his
Füßen und gestand[30] alles ein, und wie nur
fue'-sen unt ge-stand' al'-les ine unt vee noor
feet and confessed all, and how only
die Worte auf dem silbernen Becken:
dee vor'-te owf dame zil'-ber-nen beck'-en
the words on the silver basin,
„Bei allem was du thust, bedenke das
by al'-lem vass doo toost be-den'-ke das
"In all that thou dost, consider the
Ende!" ihn von der verruchten That
en'-de een fon dare fer-ruch'-ten taht
end!" him from the accursed deed
abgehalten hätten. Der Chan schenkte
ap-ge-halt'-en het'-ten dare kahn shenk'-te
restrained had. The khan gave
dem Arzte das Leben, ließ den
dame arts'-te dass lay'-ben leess dane
the physician his life, let the
treulosen Statthalter hinrichten[31] und
troi'-loh-sen statt'-halt-er hin'-rich-ten unt
faithless governor be executed and
sagte zu den Herren seines Gefolges:
zaach'-te tsoo dane her'-ren zy'-nes ge-fol'-ges
said to the lords of his suite:
„Habe ich wohl[32] den guten Rath des
hah'-be ich vole dane goot'-en raht des
"Have I well the good counsel of the
Derwisches zu theuer bezahlt?"
darr'-vish-es tsoo toy'-er be-tsahlt'
Dervish too dearly paid?"

REMARKS ON THE FOREGOING STUDY.

[1] *Bei* has various meanings besides the literal one, *by*. It sometimes signifies *at*, *near*, *with*; for instance, *Er wohnte bei mir*, he lived with me (in my house).

[2] *Unterwegs* reminds us of the English expression The ship is under way (moving on).

[3] *Begegnen*, to meet (imp. *begegnete*, past part. *begegnet*), governs the dative: *Es begegnete mir ein Mann*, There met (to) me a man.

[4] *Wer*, who, is often put for *Der welcher*, he who, by the use of the figure ellipsis,—as in the proverb "*Wer nicht hören will, muss fühlen*," (He) who will not hear must feel. "Who steals my purse, steals trash."—*Shakspeare*.

[5] *Ge*, as a prefix before a word, has often a meaning similar to that of the termination "ing" in English, giving a collective sense, as of many. *Flüstern*, to whisper; *das Geflüster*, the whispering (union of many whispers); *Gefolge*, union of many followers; *Krächzen*,

to croak; *das Gekräckze vieler Frösche*, the croaking of many frogs.

[6] *Der Liebhaber*, literally the fancier or amateur; from *lieben*, to love or like—thus one who has a liking for a thing.

[7] *Jedoch* is a strengthening of *doch*, yet, and introduces an idea opposite to what has gone before: *Jedoch will ich kommen*, Nevertheless I will come.

[8] *Anvertrauen* is a transitive verb, to entrust—as *Er vertraute mir das Buch an*, He entrusted the book to me. *Trauen* alone is to trust, to have confidence generally. *Trau, schau, wem*, Trust, look, whom (See who it is thou trustest) is an old proverb.

[9] *Aus-bezahlen*, to pay or count out, from *die Zahl*, the number, tale (to retail).

[10] *Warnend*, a participial adjective, warning; from *warnen*, to warn.

[11] *Meinte, dieser Rath sei*, etc. The subjunctive is here used in the second clause of the sentence, which is subjoined to or dependent upon the first: They were of opinion that this counsel, etc. N.B.—When an assertion is made positively, in the first person, the indicative mood is used even after *that* (*dasz*), expressed or understood: Ich *sage, dasz er gut* ist, I say that he is good; but, speaking in the second or third person, we use the subjunctive: Thou sayest that he is good—Du *sagst das zer gut* sei; They say that he has time—*Sie sagen dasz er Zeit* habe (subj.).

[12] *Die Sache*, the thing (affair) is less literal than *das Ding*, the thing (object).

[13] *Gerade*, literally 'straight': *eine gerade Linie*, a straight or right line.

[14] *Die Lebensregel*, the rule of life. Many compound words are made up in German of agenitive case prefixed to a noun—as, *die Todesangst*, mortal fear (death's fear).

[15] *Heimkehren*, to return home (imp. *ich kehrte heim*, past part. *heimgekehrt*). *Heim* is the English ending "ham," as in Nottingham, Saxmundham, and in German *Sachsenheim* (home of the Saxons).

[16] *Das Gefäsz*, the vessel, from *fassen*, to hold or contain. *Das Fasz*, the tub or tun: *Das Heidelberger Fasz*, the tun of Heidelberg.

[17] Literally "After a longer time."

[18] *Der Statthalter*, literally the stead-holder or deputy. The word is also frequently written *Stadt-halter*, town-holder; but the former way of spelling it is the more correct.

[19] *Räumen*, from *Raum*, room or space, to make space. Thus *aufräumen*, to clear up; *wegräumen*, to clear away.

[20] The verb *machen*, to make, when it signifies nominating to an office, is used with *zum* (*zu dem*, to the) for the masculine, and *zur* (*zu der*) for the feminine. The same with *ernennen*, to appoint, *wählen*, to choose, and similar verbs. *Sie wählten ihn* zum *Hauptmann*, they made him captain; *Sie ernannten ihn* zum *Diktator*, they appointed him dictator.

[21] *Aderlasz*, blood-letting, literally vein-letting; from *die Ader*, the vein, and *lassen*.

[22] *Die Gelegenheit*, the opportunity; from *gelegen*, the past participle of *liegen*, to lie—the time when circumstances lie favourably for a purpose.

[23] *Das Unwohlsein*, the state of being unwell; from *unwohl* and *sein*.

[24] *Auf-fangen*, to catch up. The English word "fangs" comes from the German *Fang-zähne*, teeth with which animals catch or hold their prey.

[25] *Der Augenblick*, the moment, literally the eye-glance: "In the twinkling of an eye."

[26] *Auffallen*, literally to fall upon (as a surprise, etc.).

[27] *Stumpf*, blunt; hence *der Stumpf*, the stump.

[28] *Gestehen* (whence *Geständnisz*) and *bekennen* (whence *Bekenntnisz*) both mean "to confess." But *Geständnisz* refers to the confession of a fault or crime, while *Bekenntnisz* designates also the confession or profession of a belief. Thus, *Eduard der Bekenner* is Edward the Confessor.

[29] *Verdächtig*, suspicious, is a compound of *ver* in the sense of *evil*, and *dacht*, from *denken*, to think. Thus *Bedacht* is consideration; *Andacht*, devotion, etc.

[30] *Eingestehen*, to confess, is transitive, and has an object after it; *gestehen* may be used generally: *Alles eingestehen*, to confess all.

[31] *Richten*, to judge; from *Recht*, right: *hinrichten*, to execute judgment of death.

[32] *Wohl*, well, is here expletive, or a word used to fill up or strengthen the sentence—as, "Well have I paid too dearly," etc.

Exercise on the Foregoing Study.

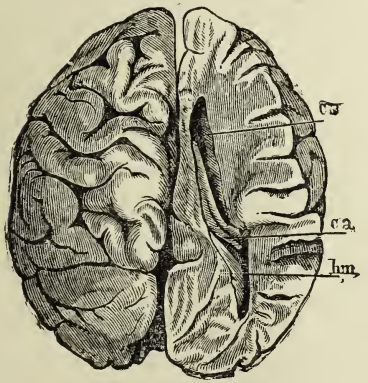
(The sentences of this exercise should be translated into German, *from memory*, after the foregoing story has been well studied. They can be corrected by the German version that follows them.)

A Dervish met a Tartar khan, who was riding (rode) to the chase. The Dervish cried: "For (a) hundred gold pieces I will give a good counsel." The khan caused (ließ) the hundred gold pieces to be paid to the Dervish; for he wished to know what this good counsel might be. The counsel, however, was this: "In all that thou dost, consider the end." The suite of the khan laughed, and said that every one knew this good counsel. But when the khan had (was) returned from the chase he caused (ließ) the words to be written on the doors and walls of his palace and engraved on (in) all the gold and silver vessels. A governor who wished to clear the khan out of the way, won the body-physician, so that the latter promised to poison his master. Some time afterwards, when he was about (wollte) to bleed (Aderlassen) the khan, he took a poisoned lancet; but in the silver basin wherein they (man) would catch the blood, he saw written: "In all that thou dost, consider the end." He hesitated, and then took another lancet. The khan, whom this struck, caused the first lancet to be shown to him. He saw that it was sharp enough, and said to the physician, "Thy terror makes thee suspicious." The physician confessed all, and how the words had kept him from the deed. The khan said hereupon to the lords of his suite: "Have I paid the counsel of the Dervish too dearly?"

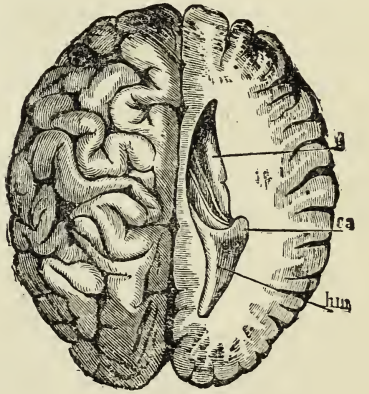
German Version.

Ein Derwisch begegnete einem Ta-
ine daré'-vish be-gay'-gne-te i'-nem tah-
taren Khan der auf die Jagd ritt. Der
tah'-ren kahn dare owf dee yahcht ritt dare
Derwisch rief: „Für hundert Goldstücke
daré'-vish reef fuer hunn'-dert gold'-stueck-e
gebe ich einen guten Rath." Der Khan
gay'-be ich i'-nen goot'-en raht dare kahn
ließ dem Derwisch die hundert Gold-
leess dame daré'-vish dee hunn'-dert gold'-
stücke bezahlen; denn er wünschte zu
stueck-e be-tsah'-len denn ayr vuensh'-te tsoo
wissen was dieser gute Rath sein möchte.
vis'-sen vass dee'-zer goot'-e raht zyne moech'-te
Der Rath, aber, war dieser: „Bei allem
dare raht ah'-ber vahr dee'-zer by al'-lem
was du thust, bedenke das Ende." Das
vass doo toost be-den'-ke dass en'-de dass
Gefolge des Khans lachte, und sagte
ge-foll-ge des kahns lach'-te unt zaach'-te
daß jeder diesen guten Rath wisse.
dass yay'-der dee'-zen goot'-en raht vis'-se
Aber als der Khan von der Jagd heim
ah'-ber als dare kahn fon dare yahcht hime
gekehrt war, ließ er die Worte an die
ge-kayrt' vahr leess ayrr dee vor'-te an dee
Thüren und Wände seines Palastes
tue'-ren unt ven'-de zy'-nes pah-las'-tes

anſchreiben und in alle goldenen und
an'-shry-ben unt in al'-le goll'-den-en unt
ſilbernen Gefäße eingraben. Ein
zil'-ber-nen ge-fays'-se ine'-grah-ben ine
Statthalter, der den Khan aus dem Wege
statt'-halt-er dare dane kahn ows dame vay'-ge
räumen wollte, gewann den Leibarzt, ſo
roy'-men voll'-te ge-vann' dane libe'-artst zo
daß dieſer verſprach, ſeinen Herrn zu
dass dee'-zer fer-sprahch' zy'-nen hayrrn tsoo
vergiften. Einige Zeit nachher als er
fer-gift'-en i'-ni-ge tsite naeh-hair' als ayrr
dem Khan Ader laſſen wollte, nahm er
dame kahn ah'-derr lass'-en voll'-te nahm ayrr
eine vergiftete Lanzette; aber in dem
i'-ne fer-gift'-e-te lant-set'-te ah'-ber in dame
ſilbernen Becken, worinn man das Blut
zil'-bern-en beck'-en vo-rinn' man dass bloot
auffangen wollte ſah er geſchrieben:
owf'-fang'-en voll'-te zah ayrr ge-shree'-ben
„Bei allem was du thuſt, bedenke das
by al'-lem vass doo toost be-den'-ke dass



BRAIN OF CHIMPANZEE.



HUMAN BRAIN.

Ende." Er zögerte, und nahm dann eine
en'-de ayrr tsoe'-ger-te unt nahm dann i'-ne
andere Lanzette. Der Khan dem dieſes
an'-de-re lant-set'-te dare kahn dame dee'-zes
auffiel ließ ſich die Lanzette zeigen.
owf'-feel leess zich dee lant-set'-te tsy'-ehen
Er ſah daß ſie ſcharf genug war, und
ayrr zah dass zee sharrf ge-nooeh' vahr und
ſagte zu dem Arzte, „Deine Furcht
zaach'-te tsoo dame arrts'-te dy'-ne foorcht
macht dich verdächtig." Der Arzt geſtand
macht dich fer-dech'-tieh dare artst ge-stand'
alles, und wie ihn die Worte von der That
al'-les und vee een dee vorr'-te fon dare taht
abgehalten hatten. Der Khan ſagte
ap'-ge-hall'-ten hat'-ten dare kahn zaach'-te
hierauf zu den Herren ſeines Gefolges:
here-owf' tsoo dane her'-ren zy'-nes ge-foll'-ges
„Habe ich den Rath des Derviſches zu
hah'-be ich dane raht des dare'-vish-es tsoo
theuer bezahlt?"
toy'-err be-tsahlt'

VIII.

MAN-LIKE MONKEYS (*continued*).—THE BALD APE.

WE are led towards the next figure of principal interest by some creatures not so well known, of which we will first consider the Nschiego Mbouvé, or bald ape, distinguished by the shortness of hair on the scalp. In many features of structure it resembles the gorilla, and has a similar habitat—the forests of the Gaboon river. The "nests" made in trees are very interesting.

Du Chaillu thus describes his first capture of this species: "Lying quite still in our concealment, we at last, just at dusk, heard the peculiar 'hew, hew, hew,' which is the call of the male to his mate. We waited till it was quite dark, and then I saw what I had so longed all the weary afternoon to see. A nschiego was sitting in his nest. His feet rested on the lower branch, his head reached quite into the little dome of the roof, and his arm was clasped firmly round the tree-trunk. This is their way of sleeping. After gazing till I was tired, two of us fired, and the unfortunate beast fell.

Du Chaillu's account.

"I was at once struck with points of difference between it and the chimpanzee. It was smaller, and had a bald black head. This specimen was three feet eleven inches high, or long. Its skin, where there is no hair, is black; the hair is blacker, longer, glossier, and thinner in general than that on the gorilla. It is not so powerful an animal as the gorilla, its chest is not so large, but the arms and fingers are a little longer, and this is the case with the toes also."

With regard to the well-woven nest, with its dome-shaped roof, Du Chaillu says it is made "of long branches and leaves, laid one over the other very carefully and thickly, so as to render the

Nests.

structure capable of shedding off water. The branches were fastened to the tree in the middle of the structure by means of wild vines and creepers, which are so abundant in these forests. There remains no doubt in my mind that these nests are made by the animal to protect it from the nightly rains. When the leaves begin to dry to that degree that the structure no longer throws off water, the owner builds a new shelter, and this happens generally once in ten or fifteen days."

The Koolo-Kamba.

The koolo-kamba is another great ape, of which the skeleton has come to Europe; its continual cry is "koolo," and it is a creature found in close association with the chimpanzee. It has a round head, whiskers running quite round the face and below the chin, prominent cheek-bones, eyes very sunken, and jaws not large and projecting. It has a somewhat larger brain-case in proportion to its size than even the gorilla. It is a capital climber, and yet is much more a creature going on all-fours than the gorilla.

On the whole, the body of the koolo has a peculiar resemblance to that of a frog, from the absence of characteristic marks of division between the chest and the abdomen. The chest is greatly extended, by being bounded by fourteen pairs of ribs. The upper limbs are very long, and the hands are more slender and manlike than those of the gorilla; they are more flexible perhaps than any other hands. But the thumb is quite short, and not capable of being stretched far outwards.

The Soko.

The soko is an animal from quite the other side of Africa, near lake Tanganyika, which appears to be quite distinct from those just mentioned, but the skin and skeleton of which have not yet been brought to Europe for exact description. He is a very inferior creature in external appearance, having a large, ugly, projecting muzzle, and great ears. We owe our knowledge of him to Dr. Livingstone.

This great traveller's description of the soko is so excellent as to its nature and habits, that we cannot do better than reproduce a great part of it. He says, in his last journal, "They often go erect, but place the hand on the head, as if to steady the body. When thus seen, the soko is an ungainly beast—a bandy-legged, pot-bellied, low-looking villain, without a particle of the gentleman in him. Other animals, especially the antelopes, are graceful, and it is pleasant to see them, either at rest or in motion; the natives also are well made, lithe, and comely to behold; but the soko, if large, would do well to stand for a picture of the devil. He takes away my appetite by the disgusting bestiality of his appearance. His light-yellow face shows off his ugly whiskers and faint apology for a beard; the forehead, villainously low, with high ears, is well in the background of the great dog-mouth; the teeth are slightly human, but the canines show the beast by their large development. The hands, or rather the fingers, are like those of the natives. The flesh of the feet is yellow, and the eagerness with which the manyuena devour it, leaves the impression that eating sokos was the first stage by which they arrived at being cannibals: they say the flesh is delicious.

Livingstone's description.

Horrible aspect.

"The soko is represented by some to be extremely knowing, successfully stalking men and women while at their work; kidnapping children, and running up trees with them, he seems to be amused by the sight of the young native in his arms, but comes down when tempted by a bunch of bananas, and as he lifts that, drops the child; the young soko, in such a case, would cling closely to the armpit of the elder. One man was cutting out honey from a tree, and naked, when a soko suddenly appeared and caught him, then let him go; another man was hunting, and missed in his attempt to stab a soko; it seized the spear, and broke it, then grappled with the man, who called to his companions, 'Soko has caught me.' The soko bit off the ends of his fingers, and escaped unharmed.

"The soko is so cunning, and has such sharp eyes, that no one can stalk him in front without being seen; hence, when shot, it is always in the back; when surrounded by men and nets, he is generally speared in the back too. He is nothing, as compared in power of damaging his assailant, to a leopard, or lion, but is more like a man unarmed; for it does not occur to him to use his canine teeth, which are long and formidable. Numbers of them came down in the forest, within a hundred yards of our camp, and would be unknown but for giving tongue like foxhounds—this is their nearest approach to speech. A man, hoeing, was stalked by a soko, and seized; he roared out, but the soko giggled and grinned, and left him as if he had done it in play. A child, caught up by a soko, is often abused by being pinched, and scratched, and let fall.

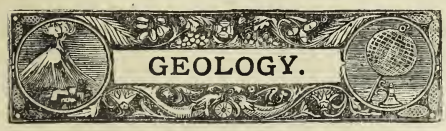
Soko and Leopard.

"The soko kills the leopard occasionally by seizing both paws and biting them, so as to disable them; he then goes up a tree, groans over his wounds, and sometimes recovers, while the leopard dies. At other times both soko and leopard die. The lion kills him at once, and sometimes tears his limbs off, but does not eat him. The soko eats no flesh; small bananas are his dainties, but not maize. His food consists of wild fruits, which abound.

Finger biting.

"Sokos collect together, and make a drumming noise, then burst forth into loud yells, which are well imitated by the natives' embryonic music. If a man has no spear, the soko goes away satisfied; but if wounded, he seizes the wrist, lops off the fingers, and spits them out, slaps the cheeks of his victim, and bites without breaking the skin; he draws out a spear, but never uses it, and takes some leaves, and stuffs them into his wound to staunch the blood; he does not seek an encounter with an armed man. He sees women do him no harm, and never molests them: a man without a spear is nearly safe from him. They live in communities of about ten, each having his own female; an intruder

from another camp is beaten off with their fists and loud yells. If one tries to seize the female of another, he is caught on the ground, and all unite in boxing and biting the offender. A male often carries a child, especially if they are passing from one patch of forest to another over a grassy space; he then gives it to the mother."



XXVIII.

LIST OF CHARACTERISTIC FOSSILS (*continued*).

LIAS.

Reptilia—Plesiosaurus Hawkinsii, P. macrocephalus, etc., Ichthyosaurus communis, I. platyodon, Scelidosaurus Harrisoni, Dimorphodon.

Fish—Dapedius, Æchmodus, Lepidotus, Leptolepis, Pholidophorus, Hybodus Acrodus, etc.

Crustacea—Eryon archæformis.

Echinoderms — Cidaris Wrightii, Hemipedina Bechei.

Mollusca—Geoteuthis Bollensis, Belemnites acutus, B. compressus, Ammonites communis, A. planicostatus, A. raricostatus, A. heterophyllus, A. serpentinus, A. exaratus, Cryptocænia expansa, Pleurotomaria anglica, Gryphea incurva. Cardina Listeri, C. acuta, Myacites unionoides, Pecten rigidus, Terebratula cornuta, T. numismalis, Rhynchonella. tetrahedra, Spirifera Walcottii, Foraminifera, Flabellaria, Polymorphina, Frondicularia.

Plants—Auracarites peregrina, etc.

TRIAS (including the Rhætic Beds).

Mammals—Hypsiprimnus, Microlestes antiquus.

Reptiles—Telerpeton Elginense, Cladyodon Lloydii, Labyrinthodon (6 sp.), Rhynchosaurus articeps, Thecodontosaurus, Cheirotherurium. Footprints numerous.

Fish—Nemacanthus, Acrodus minor, Gyrolepis Alberti, Ceratodus (many species), Hybodus Keuperinus.

Molluscs—Cardium Rhæticum, Avicula contorta, Pecten Valonensis, Axinus cloacina.

Crustacea—Estheria minuta.

Plants—Dictyophyllum crassinervum, Walchia hypnoides, Echinostachys oblongus.

PERMIAN.

Reptiles—Palæosaurus, Platyodon.

Fish—Acrolepis Sedgwickii, Cœlacanthus caudalis, Gyracanthus formosus.

Molluscs—Pleurotomaria, Schizodus, Gervillia socialis, Camarophoria Schlottheimii, Athyris pectinata, Strophalosia Goldfussi, Productus horridus, Lingula Credneri.

Sponges—Mammilopora mammillaris, Bothroconis plana, Scyphia tuberculata, Tragos Binnegi.

Corals—Aulopora Voigtiana, Chaetitis (2 sp.), Polycœlia.

Hydrozoa—Syncladia virginea, Fenestella retiformis.

Plants—Confervitis, Neuropteris, Psaronites, Nœggerathia, etc.

CARBONIFEROUS.

COAL MEASURES.

Reptiles — Archegosaurus, Anthracosaurus Russelli, Parabatrachus.

Fish—Rhizodus Hibberti, Megalicthys Hibberti, Amblypterus nemopterus, Gyracanthus tuberculatus, Pleuracanthus, Cœlacanthus.

Crustacea—Limulus Prestwichii.

Annelida—Spirorbis carbonarius.

Insecta — Blattina, Gryllacris, Euphorbis, Xylostrobus.

Mollusca—Goniatilis Listeri, Nautilus discus, Natica vetusta, Pleurotomaria, Bellerophon hiulcus, Productus squamatus, Discina lævis, Spirifera bisulcata, Anthracosia, Anthracomya, etc.

Plants—Lepidodendron Sternbergii, L. elegans, Calamites cannæformis, Sigillaria reniformis, Pecopteris abbreviata, P. serra, P heterophylla, Neuropteris Loshi, N. gigantea, Sphenopteris, Sphenophyllum, Cardiocarpon, Trigonocarpum, Pinites, etc.

CARBONIFEROUS LIMESTONE.

Fishes — Psammodus rugosus, Petalodus Hastingsæ, Cochliodus contortus, Ctenacanthus. etc.

Crustacea—Phillipsia pustulosa, Globiconchus Scouleri, Cypridina Burdigalensis, Dithyocaris.

Echinodermata — Woodocrinus macrodactylus, Actinocrinus amphora, Palæachinus, Archæocidaris Urii.

Mollusca — Orthoceras inæquiseptum. O. maximus, Goniatites obtusus, G. vittagis, Nautilus carinatus, Euomphalus pentangulatus, Macrocheilus imbricatus, Pleurotomaria flammigera, Sanguinolites, Aviculopecten papyraceus, Conocardium Hibernicum, Terebratula hastata, Spirifer, Fenestella plebia, Ptylopora gracilis, Striatella.

Corals—Amplexus coralloides, Cyathophyllum Murchisoni, C. Stutchburyii, Lithostrotion Martini, L. irregularis, L. basaltiforme, Syringopora reticulata.

DEVONIAN.

Fish—Osteolepis major, Diplacanthus striabulus, Pterichthys Milleri, Coccosteus, Cephalaspis Lyellii, Holoptychius nobillissimus, Cheiracanthus latissimus.

Crustacea—Stylonuris Powreii, Eurypterus Anglicus, Phacops, Bronteus flabellifer, Cheirurus.

Echinodermata—Actinocrinus Echinospheronites, Cupressocrinus (sp.).

Mollusca—Macrocheilus subcostatus. Megalodon, Anadonta Jukesii, Dolabra, Avicula Orthoceras, Cyrtoceras, Clymenia, Goniatites, Uncites, Spirifera disjuncta, Sp. calcarata. Atrypa desquamata, Stringocephalus, Burtini, Orthis rhomboidalis.

Corals—Heliolites porosa, Favosites polymorpha, Arachnophyllum typus, Smithia Pengellyi, Acervularia pentagona, Stromatopora concentrica.

Plants—Palæopteris Hibernica, Knorria Bailyana, Psaronius, Psilophyton robustus, P. princeps.

UPPER SILURIAN.

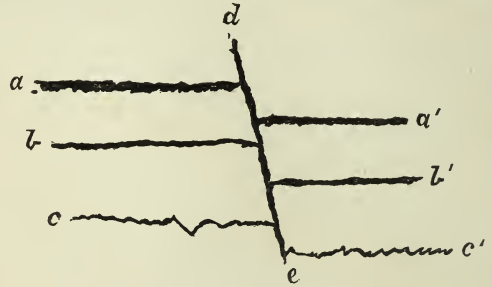
Fish—Onchus, etc.

Crustacea—Slimonia acuminata, Pterygotus bilobus, Eurypterus, Homalonotus Knightii, Calymene Blumenbachii, Phacops caudatus, P. Stokesii, Encrinurus variolaris, Lichas, Cyphaspis megalops.

Annelida — Serpulites longissimus, Tentaculites ornatus.

Echinodermata — Glyptocrinus, Periechocrinus, Actinocrinus capillaris, Taxocrinus tuberculatus, etc., Palæaster Miltoni, Palæcoma Marstoni. Cephalopoda —Orthoceras imbricatum, O. ludense, O. bullatum.

Mollusca—Murchisonia Lloydii, Pleurotomaria balteata, Euomphalus rugosus, Acroculia vetusta, Pterinea retroflexus, Ctenodonta, Grammysia cingulata, Pentamerus Knightii, Strophomena depressa, Rhynchonella borealis, Atrypa reticularis, Athyris tumida, Lingula Lewisii.



GEOLOGICAL "FAULTS."

Echinodermata—Palæasterina, Democrinus.

Mollusca—Orthoceras vagans, O. primæva, Lituites cornu-arietes, Arca, Palæarca, Glyptarca, Lingulella Davisii, Obolella.

Corals—Petraiia elongata, Chaetites, Favosites.

Hydrozoa—Dictyonema sociale.

Sponges—Protospongia.

CAMBRIAN.

Crustacea—Microdiscus sculptus, Agnostus Cambrensis, Conorcoryphe Lyellii, C. Solvensis, Paradoxides Harknessii, Plutonia Sedgwickii, Palæopyge Ramsayi, Leperditia Cambrensis.

Annelida — Histioderma Hibernica, Arenicolites sparsus.

Mollusca — Theca antiqua, Lingulella ferruginea, L. primæva.

Hydrozoa — Oldhamia antiqua and O. radiata.

Sponges— Protospongia.

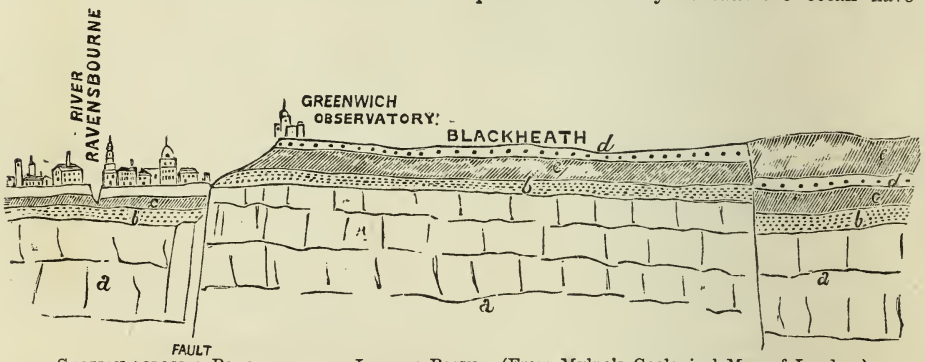
LAURENTIAN.

Unfossiliferous in Great Britain.

SUPPLEMENTARY NOTE.

Faults.

We have seen that movements in the earth's crust have been very common from the earliest periods of which we have any record. Strata originally deposited horizontally beneath the ocean have been sometimes raised to enormous heights, tilted at all angles, and often greatly bent and contorted; and it should have been explained in an earlier lesson that one frequent result of these movements is the production of "faults." This term, which had its origin in mining operations, is in common use to describe displacements of strata by which those on one side of a fissure or fracture are thrown out of their proper relation to strata on the other side. Thus, supposing *a*, *b*, *c*, and *a'*, *b'*, *c'* in the accompanying diagram to represent mineral veins, and the line *d e* a fracture, the miner, having commenced working at *a*, would



SECTION ACROSS A PORTION OF THE LONDON BASIN. (From Mylne's Geological Map of London.)
a. Chalk. *b*. Thanet Sand. *c*. Reading and Woolwich Beds. *d*. Oldhaven Pebble Beds.

Corals—Favosites aspera, Heliolites Murchisoni, Halysites catenularius, Labechia conferta, Strombodes Murchisoni, Acervularia luxurians.

Hydrozoa—Graptolites Sedgwicki, G. priodon, Diplograpsus, Didymograpsus, Rastrites peregrina, etc.

Plantæ—Fucoids.

LOWER SILURIAN.

Crustacea—Niobe Homfrayi, Angelina Sedgwickii, Ampyx nudus, Ogygia Buchii, Olenus, Agnostus, Harpes Flanagani, Phacops longicaudatus, Paradoxides Davisii, Trinucleus concentricus, Hymenocaris, Ceratiocaris Wrightii, etc.

find himself on reaching *b* brought abruptly to a stop, the continuation of the vein having been thrown down to *a'*, or, which would be practically the same thing, the portion of the vein which he had been working having been raised so much.

Faults vary greatly in size; they are sometimes almost microscopically small, and sometimes thousands of feet in depth.

Illustrations. The diagram on the opposite page is a section across faults in the London basin in the neighbourhood of Greenwich and Blackheath, and the dislocation of the strata represented will be seen at a glance. On the right hand of the diagram the Oldhaven pebble beds are buried under a considerable depth of London clay; on the other side of the fault they lie on the surface; and the London clay, which

FIG. 87.—THE APENNINES AND WALLED-PLAIN ARCHIMEDES.

originally covered them, has been removed by denudation.

This, however, is but a very trivial disturbance compared with what is called the Pennine fault, the maximum depth of which is estimated at from 6,000 to 7,000 feet. It commences in the south of Scotland, "and runs southward to near Brough, in Westmoreland. On the eastern side carboniferous rocks, Old Red Sandstone, and even Silurian strata, are brought against the Permian rocks on the west. The fault continues by Kirkby Stephen to near Kirkby Lonsdale, this portion being considered the continuation of the Pennine fault" by some geologists; and by others the commencement of another fault called the Craven Fault.

In mining phraseology the underground dip of the dislocated strata is called the *hade* or *underlie*, the amount of the shifting is designated the *throw*, and the grooved or polished surfaces often produced on the sides of fractures by the friction of their movements have received the name of *slickensides*.

Throw and hade of fault.

It will be easily understood that there must be many varieties of fault, according to the direction of the disturbing force, the position of the strata when the movement occurs, and other circumstances. It will also be seen that faults upon a large scale must often have a very marked effect upon scenery, frequently determining the flow of rivers and the existence of valleys.

Varied character of faults.

END OF "GEOLOGY."

XXXIV.

THE MOON (*continued*).

THE principal walled- and ring-plains on the moon are named after celebrated astronomers, as Plato, Archimedes, Copernicus, Newton, Herschel, etc.

The larger formations of the moon of this class are the *walled-plains*, which range in diameter from 40 to 160 miles, and resemble mere level tracts of surface enclosed on all

sides by very irregular broad masses of mountain ranges, frequently rising in places into peaks of from 10,000 to 20,000 feet in height. Of smaller size and more regular form are the *ring-plains*, which range in diameter from twenty to sixty miles, and possess broad walls reaching at times to an elevation of 15,000 feet above the interior, though seldom as much above the surrounding surface—for it is a noteworthy thing in connection with these ring-plains that the interior is much below the level of the exterior. The walls of the ring-plains are much terraced, and are generally ten times as broad as they are high. The *craters* are somewhat similar in appearance to the more regular ring-plains, but are smaller, seldom exceeding ten miles in diameter, and are everywhere surrounded by a highly disturbed rugged surface, having all the appearance of being volcanic in nature. Round about the principal craters are usually to be found many bright minute crater-cones, about 1000 feet in height, and with a crateriform orifice some half a mile or so in diameter. These small crater-cones seem to be the true representatives of our terrestrial volcanoes, just as the larger *craters* would seem to correspond to the large but now extinct craters of the earth. The smaller of the craters are called *craterlets*. By *crater-pits* are meant the small crateriform-looking formations so abundant on the moon, resembling small shallow cup-shaped, or rather saucer-shaped, depressions, which are not easily distinguished from the true *craterlets* at a first glance, but differ from them in being extremely shallow—being often not more than a hundred yards deep—though several miles in diameter, and in the very slight slope of their walls. In some portions of the moon these formations seem to cover the surface, but they disappear from view within a few hours after they become visible. They have nothing of the crater nature about them, but correspond to the shallow depressions and dimples so common on the earth. Without exaggeration, it may be said that the greater number of them would altogether be invisible as depressions to any one placed in their centre.

The last class of lunar formations which need be referred to is that whose members are called *rills* or *clefts*. These resemble long canals with parallel banks, varying in width from 1000 to 3000 feet, and in depth from 100 to 500 feet, whilst in length they vary between 10 and 400 miles. They mostly seem to be connected with the systems of valleys, traversing the mountain region, whilst they themselves usually run along the lower-lying more level districts. They are usually either straight or but slightly curved; occasionally they end in some definite manner, as at the mouth of a valley or break in a walled-plain, but usually disappear insensibly. At times they seem to cut through all intervening objects, but at others to be interrupted by mounds or craters, only to reappear beyond and pursue their course in the same direction as before. The origin of these peculiar formations is unknown, or even what is their nature, but they seem to have at times acted as river beds; though this has been merely an accident due to their favourable position. These *rills* will be found shown on both the drawings of the *Apennines* and on the region near *Mösting* (see pp. 226 and 257).

The conclusions to be drawn from a careful study of the lunar surface is, therefore, that the moon, though no copy of the earth, has been moulded by the same forces, but in a modified manner. Owing to the smaller force of gravity, the volcanic energies have been manifested on a larger scale upon the moon than on the earth; whilst, owing to the more rapid and the complete absorption of the primitive oceans and seas, the process of disintegration and erosion on the moon have not reached anything like the advanced state found on the earth. In these respects, therefore, we find very different conditions prevailing upon the surface of the two bodies. The absence of water necessitates the absence of both clouds and rain, and therefore of vegetation, or rather of such luxuriant vegetation as is found on the earth. It is not improbable that some kind of vegetation may exist upon the moon, especially within the deeper valleys and ring-plains, where it would to a certain extent be shielded from the sun. Some moisture may be present in such places, to be liberated when the sun is high, and deposited as dew and reabsorbed by the surface during the lunar night. And it is noteworthy that certain periodical changes in colour have been observed in such situations, and have been thought to be indications of the existence of such vegetation.

It has been thought very probable that the volcanic energies of the moon are no more extinct than those of the earth; and several instances of supposed changes on the moon have been suspected, and more or less certainly established. The search for such changes, and the study of the conditions under which they occur, is not the least important branch of selenography, and may be expected to throw much light on the past history and future career not only of the moon but of its primary the earth.

XXXV.

Rule of Three.

Definition:—

(1) Two quantities are said to be in *direct* proportion if they are so related that when the one is increased two, three, four . . . times, the other is also increased the same number of times.

(2) Two quantities are said to be in *inverse* proportion if they are so related that when the one is increased two, three, four . . . times, the other is *diminished* the same number of times.

The Rule of Three is the name given to a process by which, when three numbers or quantities related to each other in a certain way are given, we can find a 4th number or quantity which shall bear to the 3rd the same ratio that the 2nd bears to the 1st. Thus, to take a very simple case, if we are given 3 numbers, A, B, C, we can find a 4th, D, such that its ratio to C is equal to B's ratio to A. For we have

$$A : B :: C : D,$$

$$\therefore D = \frac{B \times C}{A}$$

As we have said, the quantities must be related to each other in a certain way, namely:—

(1) Two of the given quantities, if they are not abstract numbers, must be quantities of one and the same nature. And the third and required quantities must also be of one and the same nature, though not generally of the same nature as the first two; *e.g.*, the first two might be *weights*, and the third and required quantities *money*.

Also (2) the first kind of quantity must be proportional, either directly or inversely, to the second kind of quantity; *e.g.*, if the first two were weights of, say, coal, and the third and required terms were prices of these weights, the latter kind of quantity—namely, price—is proportional to the former kind—namely, weight.

If we were expressly told the order in which the quantities are to be taken, we should have no difficulty in finding a fourth proportional by simply applying the rule of proportionals, by which we know that the 4th term = $\frac{\text{2nd term} \times \text{3rd term}}{\text{1st term}}$.

But, in fact, the chief difficulty in examples of the Rule of Three is to arrange the quantities in their proper order. To do this correctly we must attend to the following points, which, in fact, constitute the rule.

Of the three quantities which are given, look for that which is of the same kind as the required fourth quantity, and put it as the 3rd term of a proportion.

Then consider, from the nature of the question, which of the two remaining terms corresponds to the required 4th term, and put this one in the 2nd place of the proportion if the proportion is direct, but in the 1st place if it is inverse. The remaining term, of course, goes in the remaining place.

If the proportion be *direct*, the term corresponding to the required one will be the greater or less of the two, according as the required one is greater or less than the 3rd; and therefore the greater or less of the two is to be in the 2nd place, according as the required term is to be greater or less than the 3rd term.

If the proportion is *inverse*, the term corresponding to the required one will be less or greater than the other according as the required one is greater or less than the 3rd term, and therefore the less or greater of the two is to be put in the 1st place, according as the required 4th term is greater or less than the 3rd term.

So that in either case, whether the proportion be direct or inverse, the 2nd term is to be the greater or less, according as the required term is greater or less than the 3rd term.

Bearing in mind all that has been said, we may now state the rule briefly, for practical purposes, in the following form. *Rule*—Of the three quantities which are given, take that which is of the same kind as the required or 4th quantity, and put it in the 3rd place of the proportion. Consider, from the nature of the question, whether the required quantity will be greater or less than this given third quantity; if greater, then the *greater* of the two remaining quantities is to be put in the 2nd place, and the lesser in the 1st place; but if the required quantity is to be less than the given 3rd quantity, then the lesser of the two remaining quantities is to be put in the 2nd place, and the greater in the 1st.

We have now got the proportion between the quantities stated in the form

$$A : B :: C : \text{required quantity}.$$

But before we can apply to this statement the rule for finding the 4th term of a proportion, we must take care to reduce the 1st and 2nd terms to one and the same denomination, and also to reduce the 3rd term so that it may be all expressed in some one denomination, which need not be the same as that in which the 1st and 2nd are expressed.

When the terms have thus been reduced, multiply the 2nd by the 3rd, and divide the product by the 1st term, treating all three terms as abstract numbers. The quotient so found will be the required quantity expressed in the same denomination as that to which the 3rd term was reduced.

A few examples will make clear all that we have said.

Example (1).—If 5 men require 6 lb. of meat per diem, how many pounds will 9 men require?

We assume that the quantity of meat consumed will be proportional to the number of men.

The statement of our proportion will be 5 : 9 :: 6 : required number of pounds. We shall explain how this is arrived at.

The three given things are 5 men, 9 men, and 6 lb. of meat; and the required 4th thing is a certain number of pounds of meat. According to the rule, we write in the 3rd place of our proportion that quantity which is of the same kind as the required one; therefore 6 lb. will be the 3rd term of our proportion. Now, since the required number of pounds is the amount which 9 men would eat, it will clearly be greater than 6 lb., which is what 5 men eat; therefore the greater of the remaining two given things is to be put in the 2nd place, and the less in the 1st place. Therefore the statement is what we have written above, namely:—

$$5 : 9 :: 6 : \text{required number};$$

$$\therefore \text{required number} = \frac{6 \times 9}{5} = 10\tfrac{4}{5} \text{ lb}$$

Example (2).—If 3 tons 4 cwt. of coal cost £4 10*s.*, what will be the cost of 8 tons?

Here the three given things are the two weights, 3 tons 4 cwt., and 8 tons, and the cost.

£4 10*s.*; and the required 4th thing is the *cost* of 8 tons. Therefore the required cost of 8 tons will be the 4th term, and the given cost of 3 tons 4 cwt. will be the 3rd term, of our proportion. We assume that the *cost* of coal is directly proportional to its *weight*, and therefore the 4th term will be greater than the 3rd. Hence the 2nd term must be greater than the 1st—*i.e.* the 8 tons will be the 2nd term and the 3 tons 4 cwt. the 1st term.

Our statement is therefore—

3 tons 4 cwt. : 8 tons :: £4 10*s.* : required cost.

Before we proceed with our calculations we must reduce the 1st and 2nd terms to some one denomination—say, tons—and the 3rd term to one denomination—say £.

Our proportion will then be

$3\frac{1}{5}$ tons : 8 tons :: £$4\frac{1}{2}$: answer expressed in £.

$$\therefore \text{Ans.} = \frac{8 \times 4\frac{1}{2}}{3\frac{1}{5}} = \frac{8 \times 9 \times 5}{2 \times 16} = £11\frac{1}{4} = £11\ 5s.$$

In this example, instead of expressing the 1st and 2nd terms in tons, we might have expressed them in cwts. or any lower denomination; and we might have expressed the 4th term in shillings or pence. But generally it is best to express our terms in the highest denomination we can, never forgetting that the 1st and 2nd terms must be of *one and the same denomination.*

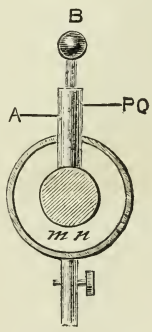


FIG. 32 (*see* p. 230).

The answer, of course, will always be expressed in that denomination to which the 3rd term has been reduced.

Example (3).—If 8 men do a piece of work in 20 days, how long will 5 men take to do it? Here the three given things are 8 men, 5 men, and 20 days; and the thing required is a certain number of days. Therefore 20 days will be the 3rd term. We assume that the time of doing a piece of work is *inversely* proportional to the number of workers—*i.e.*, that if the number of workers be increased 2, 3 . . . times, the time occupied will be diminished 2, 3 . . . times. Hence 5 men will require more time than 8 men—*i.e.*, the required quantity will be greater than the 3rd term—and therefore the greater, viz. 8, will be the 2nd term, and the lesser, 5, the 1st term.

The proportion is therefore

5 : 8 :: 20 : required number of days,

$$\therefore \text{required number of days} = \frac{8 \times 20}{5} = 32 \text{ days.}$$

Observe that in this question the proportion between number of men and number of days is *inverse*, not direct, and therefore by the rule the quantity corresponding to the 4th term is to be placed in the 1st, not in the 2nd, place. This is in agreement with the above statement.

These examples might have been worked in another way which it is useful to notice. It is called the method of Reduction to the unit.

Thus example (1) :—

Since 5 men require 6 lb.

$\therefore$ 1 man „ $\frac{6}{5}$ lb.

$\therefore$ 9 men „ $9 \times \frac{6}{5}$ lb. $= 10\frac{4}{5}$ lb.

Example (2) :—

3 tons 4 cwt. cost £4 10*s.*

or $3\frac{1}{5}$ tons „ £$4\frac{1}{2}$

$\therefore$ 1 ton „ £$\frac{4\frac{1}{2}}{3\frac{1}{5}}$

$\therefore$ 8 tons „ $8 \times \frac{4\frac{1}{2}}{3\frac{1}{5}} = \frac{8 \times \frac{9}{2}}{\frac{16}{5}}$

$= £11\ 5s.$

Example (3) :—

8 men take 20 days

$\therefore$ 1 man takes 8×20 days

$\therefore$ 5 men take $\frac{1}{5}$ of $8 \times 20 = 32$ days.

Since a ratio is not altered in value by dividing both its terms by any number, it follows that we may divide the 1st and 2nd terms of a proportion by any number.

Suppose, for instance, the proportion

21 : 15 :: 14 : required term.

This may be written $\frac{21}{15} = \frac{14}{\text{4th term}}$, and $\frac{21}{15} = \frac{7}{5}$;

so that we have 7 : 5 :: 14 : 4th term.

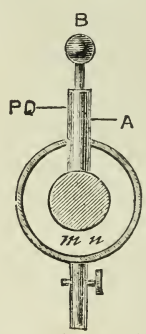


FIG. 33 (*see* p. 230).

Again, we may divide or multiply both the 1st and 3rd terms by any number: *e.g.*, in above proportion

$$\frac{7}{5} = \frac{14}{\text{4th term}}.$$

Clearly we may divide both numerators by 7, for that is equivalent to dividing both the fractions by 7.

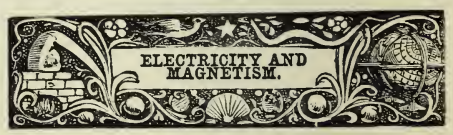
Our proportion may therefore be written

1 : 5 :: 2 : required term.

That the 4th term is not altered by either of the above operations is evident,

$$\text{for 4th term} = \frac{\text{2nd term} \times \text{3rd term}}{\text{1st term}},$$

and in this fraction we may strike out any factor common to the 1st and 2nd terms, and any factor common to 1st and 3rd terms.



IX.

Frictional Electricity (*continued*).

Faraday's next step (to continue the subject of our last article) was to fill the space *m n* of the second apparatus with shell-lac instead of air, and to proceed as before. In one experiment the free electricity of the first apparatus, before being connected with the second, produced a torsion of 290°, whereas, when the two knobs were connected, that of the sphere containing air gave a torsion of 114°, while that

of the second sphere containing shell-lac was but 113°, the two amounts together only being equal to 227° instead of 290°. Of the total quantity of electricity, therefore, the shell-lac had taken 176°, and the air 114°. Faraday therefore came to the conclusion that the inductive power, or, as he termed it, *the special inductive capacity* of air, is to that of shell-lac in the proportion of 114 : 176 or as 1 : 1·55.

By a series of similar experiments with other insulators, the specific inductive capacities of these substances, or *dielectrics* as they are termed, (conductors being called *anelectrics*), have been ascertained. In the subjoined table the most important of these results are given:—

Dielectric value of certain substances.

Air . . .	1·00	Glass . . .	1·90
Spermaceti	1·45	Shell-lac . .	2·00
Resin . .	1·76	Sulphur . .	2·24
Pitch . . .	1·80	India rubber .	2·80
Wax . . .	1·86	Gutta percha .	4·00

By the following simple experiment we may illustrate the effect of a dielectric in induction. Let an electrified body be placed at a certain distance above a gold-leaf electroscope, by which, of course, a certain divergence of the leaves is produced. If now a disc of sulphur or shell-lac be interposed between the electrified body and the disc of the electroscope, the divergence of the leaves will be sensibly increased.

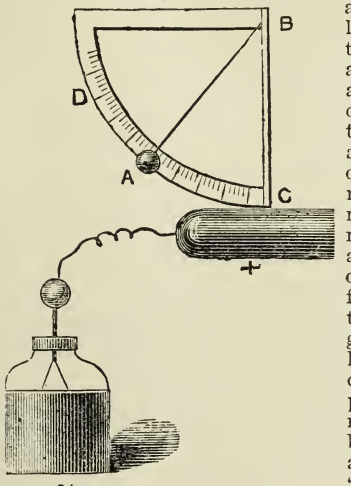


FIG. 34.—PITH-BALL ELECTROMETER.

Atmospheric Electricity.

The facts connected with this branch of our subject are tolerably familiar to us all, and we shall therefore only very briefly allude to them.

The well-known philosopher, Benjamin Franklin, was the first to prove conclusively that the electricity which produces the lightning and the thunder is precisely identical with the electricity which we obtain upon a smaller scale by artificial means.

Franklin's experiments.

For this purpose Franklin constructed a kite armed with a number of sharp points, and held by a damp string, the lower end of which was connected with a dry silk cord, which was attached to a tree, and served as an insulator. To the lower end of the string a small key was also attached. This kite being sent up on a stormy day, Franklin found that he could obtain sparks of electricity from the key, just in the same manner as from any ordinary electrical apparatus, and by various trials he was enabled to thoroughly satisfy himself that the "fire" which he thus veritably "brought down from heaven," was of the same nature as the electricity with which he was familiar. The electricity thus obtained was not, as Franklin thought, absolutely abstracted from the thunder-clouds, but was the result of the decomposition of the electricity in the kite and string, by the inductive action of the electrically charged atmosphere.

In an ordinary thunderstorm we have clouds which are oppositely electrified discharging towards each other, or we may have a direct discharge between the earth and the oppositely electrified clouds. In either case the lightning-flash is, of course, the electric spark, while the thunder is the noise accompanying that spark, which is usually greatly intensified by echoes.

Phenomena of thunderstorm.

There are usually said to be three or four kinds of lightning. First there is what is generally known as "sheet lightning," which seems to occur in the clouds themselves; then there is the common "zigzag" lightning, in which we see the exact counterpart of the discharge from an electrical machine; then again we have "summer lightning," after which no thunder is usually heard, and which probably occurs at such a distance from the observer that the rolling of the thunder cannot reach him; again we have the much more dangerous, and happily also more unusual, form of lightning known as "globe lightning," in which the flashes appear as globes of fire, frequently descending in the form of "thunderbolts" to the earth, and exploding with great noise; while, lastly, we have the kind of brush discharge which takes place from pointed bodies, such as the mast of a ship or a soldier's bayonet, towards the clouds, and is popularly known as "St. Elmo's fire."

Varieties of lightning.

A peculiarity of these atmospheric disturbances is what is known as the "return shock," which is often experienced, and which, though not often fatal, is sometimes very disastrous in its effects. This shock, which is frequently experienced at a distance from the place where the lightning discharge passes, is due to the inductive action of the thunder-cloud upon bodies on the earth. By this inductive action the neutral electricity of a body is decomposed, and it eventually becomes charged with electricity of the opposite kind to that of the cloud. When, however, this cloud becomes neutralized by its discharge, its inductive action ceases, and there is at once a return to the neutral condition on the part of all bodies which were previously influenced by the cloud, and the sudden entrance of electricity from the earth into these bodies in order to effect their neutralization produces what is known as the *return shock*.

The return shock.

One of the most important fruits of the discovery of the identity of atmospheric elec-

tricity with that artificially obtained was the invention of the *lightning conductor*.

As is well known, this consists usually of a rod tipped with gilt copper or platinum, and projecting some eight or ten feet above the roof of the edifice which is to be protected. This is connected with a conductor, consisting of an iron rod (or better, an iron rope), passing down the wall of the building and penetrating some few yards into the earth, where it is either led into a well or imbedded in a hole filled with wood-ashes, which latter are not only very good conductors, but also prevent the rusting of the metal.

Action of lightning conductors.

A lightning conductor protects a building from injury when a storm is passing over it in one of two ways. Either a lightning flash may pass, and, instead of striking the building, descend into the earth by the rod, which is a much better conductor than the building to which it is attached; or the cloud may be neutralized without a discharge by the passage of electricity of the opposite kind up the conductor. This latter way of preventing a flash of lightning by neutralizing the thunder-cloud is probably the most usual way in which the conductor acts.

Normal atmospheric electricity.

Although the electricity in the atmosphere is most apparent during a thunderstorm, it must be borne carefully in mind that there is always some amount of free electricity in the air. When the sky is cloudless this electricity is always positive—varying, however, in intensity with the height of the locality and with the hour of the day. When the sky is obscured by clouds, the electric condition of the air is sometimes negative and sometimes positive, while in foggy weather it appears to be strongly positive.

A great many attempts have been made to account for the existence of free electricity in the atmosphere, but no thoroughly good hypothesis has yet been propounded. Amongst other theories it has been supposed to result from the friction of the air against the ground, from the phenomena of vegetation, and from evaporation; while by others it has been supposed that the earth is a huge voltaic pile, and by still others that it acts as an immense thermopile. No one of these hypotheses is thoroughly satisfactory, and it is probable that the true explanation will be found in the combination of several of these supposed causes.

Electrical measurement,

We have more than once in the course of these lessons had to speak of the *quantity* of free electricity which a body possesses; and before closing these papers upon frictional electricity, it is necessary that we should understand the structure and mode of action of the principal instruments used in electrical measurements.

The unit of electrical measurement.

First, however, it will be necessary for us to adopt some unit of measurement in which we may express any results which, by means of such instruments, we may be able to obtain. The unit usually adopted is one which considers the velocity conferred upon an electrified body when repelled by a similarly electrified body, and is expressed as "*that quantity of electricity which, when the two bodies are at a distance of one centimetre, will cause them to impart to each other a velocity equal to one centimetre per second for each gramme weight of matter.*" To those who are not familiar with the metric system this definition may seem somewhat puzzling, but a glance at a table of the metric system—with which, by the way, every student should familiarize himself—will suffice to make it perfectly clear.

The pith-ball electrometer.

One of the simplest pieces of apparatus used in electrical measurement is the so-called *Quadrant*, or, better, *Pith-ball electrometer*. This, as its names imply, consists of a small quadrant scale, D (fig. 34), which is attached to a brass rod, B C, which fits into a hole in the prime conductor of an electrical machine. To B C, at B, is hinged a light wooden rod, on the further extremity of which a pith-ball, A, is attached. When the machine is worked the ball A is repelled until a maximum height, indicating a maximum potential of the electricity of the machine, is reached. Beyond this point all electricity produced by the machine escapes into the air. If a Leyden jar be attached to the prime conductor, it will take a longer time to reach this maximum, but as before, when it *is* reached, no amount of working the machine will increase the charge of the jar.

VIII.

MASS (*continued*).

Mode of using Atwood's machine.

§ 32. We will now describe some of the experiments that can be tried with the instrument we have described at such length (see p. 237). For the sake of simplicity, we will leave out of sight some of the forces that come into play: we shall say nothing about the friction of the apparatus, about the rigidity of the cord, and so on.*

Supposing, then, that we have a machine in which the friction does not exert any appreciable effect, we will put a mass of $7\frac{3}{4}$ oz. on each end of the cord: the extra mass we will take to be $\frac{1}{2}$ oz. Upon the rod two rings are placed in position; the upper to take off the

* It may be well to mention here that the friction, when regular, may be neutralised by adding a small mass to the side that is falling. If the weight of this is just sufficient to overcome the friction, the whole will move, when started, with the same velocity—it will pass over equal distances in each second: if the weight is too great the velocity will increase; if too small the velocity will diminish. In trying this, the machine should be started slowly; say, it is made to move about 6 in. to 1 ft. in the second.

extra mass, while the lower one is to stop the motion of the machine, for which purpose a light metal disc is laid upon it, so that the descending mass cannot pass through. When this has been arranged the pendulum is started, and an experiment is begun by leaving the greater mass free to move just as the pendulum comes to the end of a beat. The upper ring is placed so as to remove the extra mass just at the end of the next beat—that is, just one second after the commencement of the experiment. It may take a good many trials before you get this satisfactorily. Next place the lower ring so that the descending mass strikes it one second after the removal of the extra mass by the upper ring. You will find that the distance through which the mass falls in the second after the removal of the extra mass is (very nearly) one foot. If you refer back to § 29, you will see that this shows that the descending mass had acquired a velocity of one foot per second when the extra mass was removed. In fact, when this took place, the falling body was left without any force to affect its motion, and therefore it continued to move with the same velocity. It is worth while to satisfy yourself of this by seeing that in 2 seconds after passing the upper ring the distance passed over is 2 ft.; in 3 seconds, 3 ft., and so on. We know, then, that in this particular case the body acquires a velocity of 1 ft. per second at the end of 1 second. By a similar experiment you will find that at the end of 2 seconds it has acquired a velocity of 2 ft. per second; and, in fact, you have here an instance of a body moving with uniform acceleration—its velocity is continually being changed at a certain fixed rate.

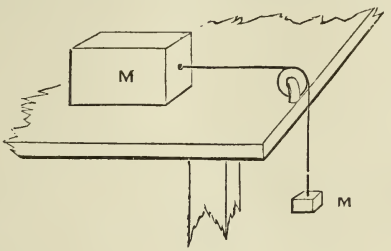


FIG. 19.

§ 33. This result at once suggests a very interesting application of the machine. We can by its means verify the conclusions already arrived at (§§ 12 to 16) with respect to acceleration. Let us arrange the masses upon the cord as may be convenient, and find the acceleration belonging to that particular case by experiment. Then we can calculate how far the body should go in such and such a time, how long it should take to get to such a place, and other like questions, in the manner already explained. The machine will enable us to verify our calculations; and every instance worked out should be tried in this way. By so doing we shall get a real grasp of statements that otherwise might have been but half apprehended, and therefore devoid of interest.

Experiments on acceleration.

§ 34. But a far more important lesson yet remains to be brought out. The only force at work in the experiment described is the weight of $\frac{1}{2}$ oz.; for we supposed we had an instrument in which friction was inappreciable, and the weight of the $7\frac{3}{4}$ oz. is counterbalanced by the weight of the equal mass on the other end of the cord. Now, from the experiment of which we have just given an account, we can express the weight of the extra mass, $\frac{1}{2}$ oz., in terms of our units of force: we can say how many poundals there are in this weight. We do this (§ 25) by multiplying the mass (in pounds) by the acceleration. But the acceleration is 1, and the mass is $7\frac{3}{4}$ oz. on one side and $8\frac{1}{4}$ oz. on the other—altogether 1 lb.* The mass, multiplied by accceleration, is therefore equal to 1; and we learn that the weight of $\frac{1}{2}$ oz. is about 1 poundal. We do not say "exactly," because our experiment is not exact. By taking the equal masses to be 7 oz. each, and the additional one to be 2 oz., you will find the acceleration produced is about 4; and since the total mass moved is about 1 lb., it follows that the weight of 2 oz. is equal to 4 poundals. Or again, if you put 23 oz. on each side, and let the extra mass be 2 oz., the acceleration produced would be about $1\frac{1}{3}$, the mass moved is 23 + 23 + 2 oz., or 3 lb.; and therefore the number of poundals in the force causing motion is 3 times $1\frac{1}{3}$, or 4. Thus, in a different way, we find that the weight of 2 oz. is 4 poundals. These results will serve to illustrate the method of measuring force, and they will give some idea of how we know that the method gives consistent results.

The "weight" of a body.

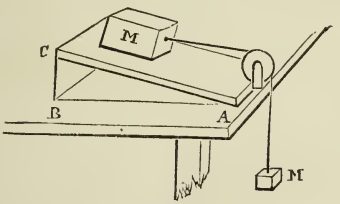


FIG. 20.

§ 35. Amongst the host of important inferences which can be made from the above we shall draw attention to one only. Suppose we have a weight of 1 lb.—that is, about 32 poundals. Let us examine the acceleration this can produce in different masses. In a mass of 32 lb. it would produce an acceleration of 1, because the mass multiplied by the acceleration must be the same as the number of poundals in the force. In a mass of 8 lb. it would produce an acceleration of 4; and in a mass of 1 lb. it would cause an acceleration of 32. Now, if you let a mass of 1 lb. fall freely, without anything to hinder it, you have a mass of 1 lb. acted on by the weight of 1 lb. (or about 32 poundals); and hence we learn that it will fall with an acceleration of 32,—that is to say, it will be moving 32 feet per second faster at the

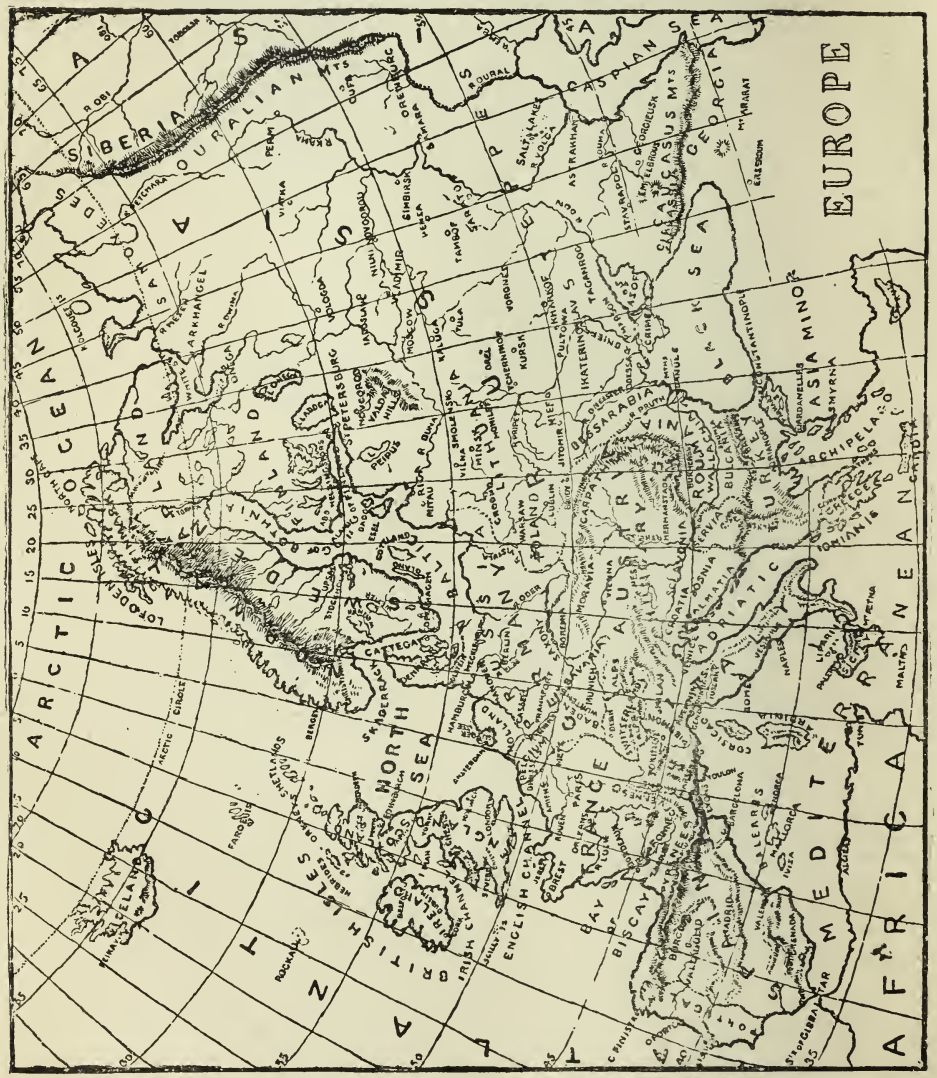
Motion of a body falling freely.

* This is not quite correct. Besides the masses attached to the cord there is another mass set in motion—viz., the wheel. But the wheel moves with different velocities at different parts. The outside moves just as fast as the cord; the portions near the axle move very slowly. If you add about $\frac{2}{3}$ of the mass of the wheel to the moving masses counted above, you will get very nearly the right result.

end of a second than it was at the beginning. The same result is obtained if you suppose the falling mass to be any other—say it is 10 lb., for example. The force in this case is about 320 poundals, which, acting on a mass of 10 lb., produces an acceleration of about 32, the same as before. So you see that when bodies fall freely, their velocity increases at the same rate, and they fall through the same distance in a given time, no matter how heavy or how light they may be. The reason is that in a heavy body we have a great force acting, but this force has to move a great mass. It is quite true, as you may suggest, that a feather and a stone do not fall equally fast in the air; but you must remember that they are *not* falling freely, and the feather is hindered (by the air) more than the stone.

§ 36. We must now leave Atwood's machine, and consider a class of experiments depending upon the same principles, and giving some results of importance. Upon a table is supported a mass M (fig. 19), which by means of a cord is attached to another mass *m*, hanging over the side of the table. Let us find out how fast it will be moving at the end of one second. Suppose, for example, that the mass M is 5 lb. and *m* is 3 lb. The weight of M, you will see, has no effect upon the motion; it does not tend to make M move to the one side or the other. The weight of *m*, then, is the force that causes the motion, and this force we know to be about 3 times 32 (or 96) poundals. The mass moved is 8 lb., because *both* M and *m* are set in motion. Therefore the acceleration

Another illustration of the second law. Friction.



—or the velocity acquired in 1 second—is 12; for this acceleration, multiplied by the mass (8), gives the force in poundals (96). A reference to § 13 will show you that the distance moved through in this second is 6 ft. But if you try the experiment, you will find the distance is less than this; and if the table is very rough, there may be no motion at all! The reason is suggested by the last remark; you get a smaller motion than was expected because of the roughness of the table, or, in other words, because of the friction; and the experiment is important, because it enables us to measure the friction and to find out a good deal about it. Suppose, for example, that we observed the acceleration obtained in the experiment above described to be 7; or, what is the same thing, that the distance described in the first second was 3½ feet only. As the mass put in motion was 8, the force required to produce this acceleration would be 8 times 7, or 56 poundals. But the force at work was the weight of 3 lb.; that is, it was 96 poundals. Hence, 40 poundals must have been used in overcoming friction. In this way you can determine the friction in any particular case; and it will be well to verify by means of actual experiment the "laws of friction." The first of these is that the friction between two particular surfaces is always the same fraction of the pressure. For instance, in the case above mentioned the friction between the table and the mass M was found to be 40 poundals. The pressure was the weight of M, or 160 poundals; so that the friction was just ¼ of the pressure. If you were to place more masses on the top of M, or to take some off, you would find the friction always ¼ of the pressure. But if you change the surfaces, the friction may be changed. If you were to put M upon a little wheeled carriage, the friction would be much smaller; you would find a smaller fraction than before, but this fraction would be the same whether you made the load 1 lb. or 20 lb. or any other weight. These fractions are called "coefficients of friction," and tables have been made showing the coefficients of friction for different pairs of surfaces.

Another way of finding the friction.

§ 37. A slight variation in the experiment just described will enable you to find the coefficient of friction in a very different manner. Suppose that instead of letting the mass M rest upon a table, we support it upon a board which can be tilted up. If we arranged matters as in fig. 19, we should find that the effect of the weight of *m* was not as great as it should be; the acceleration produced, the distance passed through, were less than we had calculated. But if we lift one end of the board as in fig. 20 we increase the acceleration, and after a few trials we can find a position of the board that will give just the right amount. Suppose this has been found: measure the height B C, and the level distance B A (see fig. 20), and note what fraction B C is of B A. This fraction ought to be the same as the coefficient of friction found as in the previous section. This will help you to check your results; but the reason must be deferred.

BY DAVID KAY, F.R.G.S.

I.

THE term GEOGRAPHY, as was mentioned in the introduction to the articles on Physical Geography (see vol. i. p. 25), is formed of two Greek words—*ge*, the earth, and *graphe*, a writing or description—and is the name given to that science which describes the earth. It is commonly divided into three parts—Mathematical, Physical, and Political Geography. MATHEMATICAL, or as it is sometimes termed, ASTRONOMICAL GEOGRAPHY, regards the earth as a member of the solar system, and treats of its figure, magnitude, motions, etc.; the position of places on its surface, and their delineation on maps and charts. PHYSICAL GEOGRAPHY treats of the surface of the earth as diversified by land and sea, mountain and lake, river, valley, plain, and the like; of the atmosphere by which it is surrounded; the materials of which its surface is composed, and the vegetable and animal life which it sustains. POLITICAL GEOGRAPHY views the earth in relation to its principal inhabitant man, and considers it as it ministers to his wants and necessities, contributes to his comforts and enjoyments, calls forth his powers and energies, and tends to his improvement in civilization and social life. It regards him particularly as he lives in states and communities under different forms of government, and differing in manners, customs, occupations, and modes of life. In other words, "it has for its object the determination of all those facts as to any given country which will enable us to judge of its fitness to provide man with food and to promote his civilization."

While it is this last branch of the science with which we have here specially to deal, it is necessary to point out that in order to a right understanding of the political or social condition of a people it is necessary to know something of the physical circumstances in which they are placed and the climatic and other influences to which they are subjected. Such is the effect of these that it has been remarked that the countries which possess the most varied physical features, having the greatest variety of climate and landscape—giving the greatest range of character and occupation to the inhabitants—have produced the most highly developed races. It is as contributing to our knowledge and understanding of Political Geography that both Mathematical and Physical Geography derive their value and importance. (See ASTRONOMY and PHYSICAL GEOGRAPHY.)

The space here allotted to us will only admit of our treating the subject in the most general and briefest manner possible, merely touching on the leading features of the different countries; but our endeavour shall be to take a brief survey of the whole field, giving a

kind of bird's-eye view of every important country, at the same time making it as interesting and instructive as possible, so as to afford a solid basis of fact, and to create a desire for further information on this great and important subject. A political description of a country includes its position, extent, boundaries; physical features; climate; mineral, vegetable, and animal productions; people; occupations, agriculture, mining, manufactures, commerce; government; religion; education; crime; history and progress.

The earth has two motions—an annual motion round the sun, and a diurnal motion on its axis. To the former we are indebted for the changes of the seasons, to the latter for the alternation of day and night. It is not a perfect globe or sphere, but is a little flatter at the poles than at any other part of its circumference, so that while the polar diameter is 7899, the equatorial is 7926 miles. Its entire area is 196,900,000 English square miles, of which the land occupies about 50,500,000, and the water over 146,000,000, or nearly three-fourths of the whole. The water forms five great oceans—the Atlantic, Pacific, Indian, Arctic, and Antarctic. The land is mostly collected into two great masses or continents—the one, the old, comprising Europe, Asia, and Africa; the other, the new, embracing North and South America. In addition to these there are numerous islands, large and small, the largest being Australia. The great geographical divisions of the land are Europe, Asia, Africa, North and South America, and Australasia. The population of the globe is variously estimated, but may probably be taken as between 1,400,000,000 and 1,500,000,000.

EUROPE.

This is the smallest, but at the same time the most civilized, and in proportion to its extent the most populous, of the great divisions of the earth. It is situated between 36° and 71° N. lat., and 9° 30′ W. and 68° E. long.; and is bounded N. by the Arctic Ocean, W. by the Atlantic Ocean, S. by the Mediterranean, the Sea of Marmora, the Black Sea, and the Caucasus, and E. by the Caspian Sea, the Ural River and Mountains, and the River Kara. Its greatest length from N.E. to S.W. is about 3,400, and its breadth from N. to S. 2,000 miles. Its estimated area is 3,800,000 English square miles, or about a fourteenth part of the whole land of the globe, and its estimated population is 320,000,000, or nearly a fourth of that of the world.

At first sight this division of the globe seems less favoured by nature than any of the others. Its rivers cannot be compared with those of Asia, Africa, or America, much of its surface is rocky and mountainous, its vegetable productions are neither very various nor exuberant, and it is poorly supplied with the precious metals. On the other hand, however, it has proportionally the greatest extent of coast-line (estimated at 19,000 miles), is abundantly supplied with those metals and minerals that are most useful to man, and has a climate well suited for the development of his energies.

Nearly two-thirds of the surface consists of an immense plain, with occasional small elevations, the remaining third being mountainous or hilly. Towards the E. this plain extends across the whole continent, from the Arctic Ocean on the N. to the Black Sea and the Caucasus in the S.; and stretches from the Ural Mountains on the E. to the shores of the Baltic, and even the Atlantic on the W. The mountainous and hilly portions lie chiefly in the S. and S.W. and the N.W. parts of the continent. The Alps form the great central mass of the mountain system of southern Europe, and stretch from the S.E. of France to the frontiers of Hungary, and between Italy and the plains of southern Germany. The loftiest summit, Mont Blanc, rises to the height of 15,784 feet. The Apennines, which are a continuation of the Alps, stretch along the Italian peninsula, forming, as it were, its backbone. The Pyrenees extend between France and Spain, and attain in their principal summit, Maladetta, a height of 11,168 feet. The great chain of the Caucasus, which forms the S.E. boundary of Europe, extends across the isthmus between the Black Sea and the Caspian, and in its highest point, Mount Elburz, rises to the height of 18,500 feet. The Ural Mountains extend S. from the Arctic Ocean through 18° of latitude, but attain no great elevation. In the N.W. of Europe are the Scandinavian Alps, called also the Dovrefield or Dofrines, extending in a N.E. and S.W. direction through the Scandinavian peninsula, and having a general elevation of from 3,000 to 6,000 feet, while some of the summits rise to 8,000.

The rivers are numerous, but few of them are of great size. The largest is the Volga, a river of Russia, which falls into the Caspian Sea, and has a length of about 2,000 miles. The Don flows into the Sea of Azoph, and the Dnieper, Dniester, and Danube fall into the Black Sea. The last is the longest river after the Volga, having a length of about 1750 miles. The most important of the other rivers draining the south of Europe are the Po, Rhone, and Ebro—the first falling into the Adriatic, the two latter into the Mediterranean. The Garonne, Loire, and Seine belong to France. The Rhine and the Elbe flow into the German Ocean, and the Oder, Vistula, and Niemen, into the Baltic. The Düna, or Southern Dvina, falls into the Gulf of Riga, and the Northern Dvina into the White Sea.

The climate of Europe is well adapted for the preservation of health and the exercise of the human powers. With the exception of a comparatively small portion in the north, it is situated within the temperate zone, and therefore is little subject to the extremes either of heat or cold. Moreover, its mean annual temperature is considerably higher than that of any of the other great divisions in the same latitudes. This is most marked on the west coast, and is owing to the prevalence of S.W. winds, which come from a tropical quarter and sweep over the warm Gulf Stream. Hence there is a great difference between the temperature of the sea-coast and that of the interior.

Also, as we advance from the coast eastward, while the mean annual temperature diminishes, the heat of summer and the cold of winter increase. Owing to the action of the W. and S.W. winds, clouds, rain, and fogs are most common on the W. and S.W. parts.

Europe does not present that luxuriance of vegetation that is found in some other parts. Its soil requires, but at the same time rewards, the labours of the husbandman. In the south many tropical plants flourish. There are found the date-palm, sugar-cane, and cotton plant; orange, olive, fig, lemon, and pomegranate trees; the vine; rice, maize, wheat, and other grains. In central Europe the vine is still found in favourable situations: apples, pears, and other fruits are common, and wheat, barley, rye, oats, and the like, are grown to a large extent. In the north only the hardier cereals—rye, oats, and barley—are extensively cultivated; while in the farthest north cultivation is impossible, and vegetation, where it exists, is only in its lowest forms. In central and southern Europe the plane, chestnut, walnut, poplar, oak, ash, beech, and other trees come to perfection; and farther north, up to lat. 67°, the pine and birch continue to flourish.

The animal kingdom is less varied than the vegetable. The most formidable wild animals are the white bear, peculiar to the Arctic regions; the brown bear, still common in the Alps and other remote mountainous districts; the wolf, still inhabiting many parts, and the wild boar. Among the other wild animals are the lynx, wild cat, badger, polecat, fox, beaver, otter, weasel, hare, rabbit, squirrel, etc. The chamois and ibex are common in the Alpine regions, and several species of deer are found in other parts. Among the domestic animals are the horse, ass, mule, reindeer (in the N.), camel (in the S.), cow, buffalo (in some S. parts), sheep, goat, pig, dog, cat, etc. The birds of Europe are in general deficient in the brilliancy of their plumage, but many of them are distinguished for the sweetness of their notes. Aquatic birds are very numerous in the northern parts. Reptiles are not numerous, and few of them are either large or venomous. Fish are abundant along the coasts, as well as in many of the inland lakes and rivers.

Though Europe is deficient in the precious metals, it possesses those metals that are most serviceable to man—iron, coal, salt, copper, lead, tin, etc.—in perhaps greater abundance than any other portion of the globe of the same extent. Iron and salt are pretty generally diffused. Coal is chiefly found in W. Europe, especially in Britain. Copper is most abundant in England, Russia, and Sweden. Silver and lead are mostly found in Spain, England, Norway, Austria, and Russia. For tin the mines of Cornwall are the richest in the world. Quicksilver is mostly found in Spain and Austria. Among the other metals found in Europe are gold, antimony, zinc, cobalt, platinum, manganese, etc.

Europe is very favourably situated for commerce. Its extensive coasts present numerous arms of the sea, gulfs, and bays, for shipping; large navigable rivers and numerous canals open up a great part of the interior; while good roads and railways are in most parts common. Of the last there are altogether upwards of 90,000 miles.

The "five great powers" of Europe are Great Britain, Germany, France, Austria-Hungary, and Russia. These and the other states we shall now proceed to notice in the following order:—Great Britain and Ireland, Germany, France, Austria-Hungary, Russia, Holland, Belgium, Denmark, Norway and Sweden, Spain, Portugal, Switzerland, Italy, Greece, Turkey, Roumania, Servia, Montenegro, Bosnia and Herzegovina, and Bulgaria and Eastern Roumelia.

XXXV.

The Stuart Period in England.—The Reign of James I. (*continued*).

The earlier part of James's reign was disturbed by several plots, of which the first two are respectively known as the Main, and the Bye or Surprising Treason. The object of the Main conspiracy, set on foot by Lord Cobham and Sir Walter Raleigh, was to dethrone the unpopular king and set up his cousin Lady Arabella Stuart, daughter of the Earl of Lennox, a younger brother of James's father, Lord Darnley, and consequently descended through Queen Margaret of Scotland from Henry VII. It was for participation in this plot that Raleigh suffered his imprisonment of thirteen years in the Tower—a captivity he beguiled by writing his "History of the World." The "Surprising Treason," in which the name of Lady Arabella Stuart was again used, was a plot for capturing the king by surprise and imprisoning him. Lady Arabella's fate was very mournful. She had nothing to do with the plots with which her name was identified, and indeed was publicly acquitted by Cecil, at Raleigh's trial, of all share in the "Main." But long afterwards, in 1610, she privately married William Seymour, who was descended from Mary, the younger sister of Henry VIII. Now, that king, in his will, had expressed a desire that in case of failure of the direct line, the descendants of Mary should inherit the crown in preference to those of Margaret; and by the marriage of Arabella and Seymour the pretensions of both lines were united. Accordingly both Seymour and Lady Arabella were imprisoned. They escaped; but Lady Arabella was recaptured, and after making vain appeals to the judges and the king for justice, died in 1616 in the Tower, driven mad by the oppressive and rigorous captivity.

Plots—The Main Conspiracy.

The "Surprising" Treason.

These plots, however, were soon forgotten in

The Gunpowder Plot, 1605.

the general consternation and horror caused by the discovery of that desperate and atrocious Gunpowder Treason, which aimed at nothing less than the overwhelming of the estates of the realm, king, lords, and commons, in one common destruction. It would be unjust to represent the Gunpowder Plot as having had the sanction or even the cognizance of the Catholic party in England generally; though undoubtedly more were concerned in it than the few with whom it is generally identified. James had in various ways raised the hopes of the Roman Catholics, and made them look forward to a new and happier era. He spoke of an intention to revise the penal laws, "which the judges might perhaps, in times past, have interpreted too rigorously." But soon afterwards these very penal laws were executed with increased severity, and supplemented by new and oppressive edicts against recusants—edicts which were looked upon with the greater indignation as coming from one who had made overtures for reconciliation to the pope, probably moved by his besetting fear of assassination, and had declared himself "much beholden to the bishop of Rome for his kind offices and temporal carriage towards us in many things," and had professed himself ready to requite these "kind offices."

CONSPIRATORS' HOUSE AT LAMBETH.

The design was to blow up the house of parliament with gunpowder on the first day of the session of November 1605. Robert Catesby, Thomas Winter, and John Wright, with whom were associated Thomas Percy of the Northumberland family, two relatives of Winter and Wright, a man named Bates, and afterwards Ambrose Rookwood, Francis Tresham, and Sir Everard Digby, were implicated therein. The vaults under the parliament house were hired by Percy, and thirty-six barrels of gunpowder were deposited there, hidden under piles of wood and coal. Guido or Guy Fawkes, an Englishman who had served in Spain, undertook the task of firing the train with a slow match on the 5th of November, the first day of the session. But a letter sent to Lord Monteagle by a conspirator, and handed to the council by that nobleman, first awakened suspicions that a plot was in hand. The obscure wording of the anonymous letter, indicating a sudden destruction by a great and sudden blow from an invisible hand, seemed to the king, or more probably the council—though James took great credit to himself for the discovery—to indicate an intention of blowing up the house with gunpowder; and, indeed, the fate of Darnley at the Kirk of Field might have suggested this solution of the mystery. A search in the vaults of the house resulted in the capture of Guy Fawkes at midnight, with dark lantern and slow matches ready to fire the train. Under the torture he divulged the names of his employers. Sir Everard Digby was, meanwhile, in Warwickshire, in readiness to head a rising of the Romanists. The other conspirators hastened to join him, on hearing of the capture of Fawkes. Several fell at Holbeach, in Staffordshire, fighting desperately and selling their lives dearly: the rest, includ-

Fate of the conspirators.

ing Fawkes and Garnett, a Jesuit, were executed—except Tresham, who died in the Tower. It was not to be wondered at that the parliament of 1005 sharpened the laws against the Roman Catholics; a new oath of allegiance was imposed, including abjuration of "the damnable doctrine and position, that princes, excommunicated or deprived by the pope, may be deposed or surrendered by their subjects, or any other whatsoever." A fine of twenty pounds per month, or of two-thirds of their lands, might also be levied upon recusants by the king.

James showed to perfection the trait that chiefly characterises the weak ruler—a tendency to be guided by showy and worthless favourites. The names of these men are indelibly stamped on the infamous page of his inglorious reign: Robert Carr, whom he made Earl of Somerset, and George Villiers, whom he made Duke of Buckingham. The worthlessness of Carr, the undeserved honours heaped upon him, the plunder of Raleigh's possessions to enrich the foolish favourite — the remonstrances of Raleigh's wife, whose child was thus despoiled of his inheritance, met with the stupid reiteration of the king's words, "I maun hae the land for Carr"—increased the disgust and contempt with which the king's worthless minion was regarded. But a deeper feeling was aroused when Somerset and his countess appeared as murderers, and when a convicted murderer could threaten the king, and plainly declare that James dared not put him to death. Sir Thomas Overbury, an unprincipled and ambitious man, at one time the intimate associate and friend of the Earl of Somerset, had strongly advised him against the marriage with Lady Frances Howard, the divorced wife of Lord Essex. The countess in revenge procured the imprisonment of Overbury in the Tower; and there, by means of four accomplices, Overbury was poisoned. Shortly afterwards Lady Frances became Carr's wife, the nuptials of the Earl and Countess of Somerset being celebrated with great magnificence. But two years afterwards the facts of the murder of Overbury came to light. The agents in the crime —Sir Jervis Elwes, Franklin, Winter, and a woman named Turner—were executed; and the king had very solemnly called upon the judges to spare none to whom the heinous guilt of secret poisoning was brought home. The Earl and Countess were put upon their trial. The latter pleaded guilty, and Carr was convicted upon the clearest evidence. But he behaved with the confidence of a man who considered himself safe in the possession of some secret power. He wrote to the king, not denying his guilt, but demanding a pardon; he never showed any fear or any sense of standing in peril of his life. James showed the utmost perturbation; and, evidently in terror that Carr would reveal important secrets, granted the pardon so strangely solicited. The general impression was that James himself was a consenting party to the death of Overbury, who, like Carr, knew some secret that he indiscreetly threatened to divulge. When the proceedings against Sir Thomas Overbury's murderers were to be begun, James had solemnly pledged himself to show no mercy to any to whom the guilt should be brought home. The hasty and terrified pardon extended to Carr was, therefore, interpreted in the worst fashion against James's honour. At the end of his reign the weak king even seemed inclined to receive Carr once more into favour; but the power of George Villiers had by that time grown too strong. This unworthy successor of an unworthy favourite began to exert his ill-omened influence immediately after the fall of Carr. Through the grades of viscount, earl, and marquis, he passed rapidly to the title of Duke of Buckingham. Without a single quality to elevate him above the most ordinary courtier, this Piers Gaveston of the seventeenth century ruled without a rival in the ignoble, drunken court of James—a fit favourite for such a master.

James and his favourites.

Carr, Earl of Somerset.

Villiers, Duke of Buckingham.

MEMORIAL OF GARNETT'S EXECUTION.

The colonization of Ulster, which province had become forfeited to the crown by the rebellion of Tyrone and Tyrconnell, put Ireland in a different and a better position with regard to the English crown. It now became a subordinate kingdom, inseparable from England, claiming similar liberties and subject to similar laws. It had before been looked upon only as a conquered province or a turbulent dependency. The great Ulster colony owes much of its prosperity to the lord deputy, Sir Arthur Chichester. A hundred and four English and Scotch colonists, called "undertakers" because they held their lands by virtue of an undertaking to fulfil certain conditions of building fortified houses, etc., fifty-six servitors or subordinates, and two hundred and eighty-six natives, now held the fortified lands of Ulster; and that province forthwith became the most enlightened part of the island.

Murder of Overbury.

The extravagance of the court, and the continual necessities of the king, drove James into the temptation of raising money, at first by doubtful, and then by illegal means. Peerages were sold for great sums of money; and the rank of baronet, a kind of hereditary knighthood, could be purchased for £1000. Many of the king's proclamations infringed personal liberty. In 1610 James incurred great unpopularity by his endeavours to revive the old feudal tax, called Aid. The parliament protested, and Cecil, the lord treasurer, tried in vain to effect a compromise by the offer of a settled revenue to the king.

James distrusted the commons, who on their part had no confidence in him. "This lower house," says the king in one of his pedantic letters, "by their behaviour have perilled and annoyed our health, wounded our reputation, emboldened an ill-natured people, encroached upon many of our privileges, and plagued our people with these delays." The parliament was dissolved in February 1611, and a new one was not summoned until four years later, in 1614. This was the well-known "addled parliament," which declined to grant the king money until grievances had been redressed; whereupon James dismissed it in a rage, before a single measure had been passed, committed some of the members to prison for contumacy, raised money by the obnoxious "benevolences," and for seven years did what he could to increase the general disgust, until want of means again forced him to assemble the two houses in 1621.

Sale of titles, etc.

The "addled Parliament."

XXXV.

Syntax of Concord.

The Third Concord—The Relative and its Antecedent.

Rule 1.—The relative agrees with its antecedent in gender, number, and person; but observe *not in case*—as in *Puer, qui amavit me, ibat*, the boy who loved me was going.

Observe that the relative means the relative pronoun *qui*, which is, you will remember, declined *qui*, masculine, *quæ*, feminine, and *quod*, neuter; and the antecedent means the word which has gone before (from *ante*, before, and *cedo*, to go), to which the pronoun refers.

Puer, the antecedent (that is, the word to which *qui* refers), being masculine, *qui* is also masculine. *Puer* being singular, *qui* is also singular. *Puer* being the *third* person, *qui* is also *third* person.

Qui is also the nominative case, and *puer* is the nominative case; but *qui* is *not* the nominative case because *puer* is, for it is the nominative case to the verb *amavit*.

The boy whom I loved was going, etc., *Puer, quem amavi, ibat, etc.*—Here *puer*, the antecedent, being *masculine*, *quem* is also *masculine*. *Puer* being singular, *quem* is singular. *Puer* being the third person, *quem* is the third person. But they do not agree in case, for *puer* is the nominative case to the verb *ibat*, whereas *quem* is the accusative case after *amavi*.

Puer edit pomum quod ei dederam, the boy ate the apple which I had given to him.—Here *pomum*, the antecedent, being neuter, *quod* is also neuter. *Pomum* being singular, *quod* is singular. *Pomum* being the third person, *quod* is the third person.

It here happens, observe, that *pomum* and *quod* are both the accusative; but *quod* is *not* the accusative case because *pomum* is the accusative, and therefore made to agree with it, for *pomum* is accusative after *edit*, and *quod* is accusative case after *dederam*. Indeed, the sentence might be—*Puer edit pomum quod datum est*, the boy eats the apple which has been given (him); and in this way *pomum* would be the accusative case after *edit* and *quod* the nominative case before *datum est*.

Remember, in construing Latin into English, always take the relative pronoun *as soon after its anteeedent* as it is possible to do so.

There is also this peculiarity in the relative pronoun in Latin as well as in English: that the accusative case must be taken before the nominative and the verb—as in "The boy ate the apple which I had given to him," we cannot say "I had given *which*," nor could the Latin say *dederam quod*, but *quod dederam*—a construction which always brings the relative as closely as possible, observe, to the antecedent to which it *refers*, and therefore called the *relative*, or *related*, or referring pronoun.

Rule 2.—When the relative has for its predicate a substantive of different gender from its antecedent, the relative usually agrees in gender with the predicate—as in *Cæsar Gomphos pervenit, quod* (not *qui*) *est oppidum Bœotiæ*, Cæsar made his way to Gomphi, which is a town of Bœotia. Here, observe, the relative "*quod*" is in the neuter gender, to agree with *oppidum*, the noun of the predicate, and not in the masculine gender plural, to agree with "*Gomphos*."

Observe, the same construction is used in the case of the demonstrative and determinative pronouns, *when used as relatives*—as in *Idem velle, et idem nolle, ea* (not *id*) *demum vera amicitia est*, to have the same likes and the same dislikes, that and nothing but that is true friendship.

Rule 3.—When the relative has for its antecedent a sentence or proposition, the latter is treated as a neuter substantive, and *id quod* is used instead of *quod*—as in *Timoleon, id quod difficilius putatur, multo sapientius tulit secundum quàm adversam fortunam*, Timoleon, a thing which is considered by far more difficult, bore prosperity not more wisely than adversity. Here *id quod* agrees in the neuter gender with the whole sentence, which is treated as a neuter substantive, as in the second concord, where we have *audito*, it being heard (neuter), *regem Doroberniam profieisei*, that the king had set out for Dover.

Rule 4.—If the relative clearly refer to two or more antecedents, then it must be placed in the plural number—as in *tu multum dormis, et sæpe potas, quæ ambo sunt corpore sano inimica*, thou sleepest much, and drinkest often, both which things are injurious to a healthy body.

Observe that when the English word "that" can be turned into "who" or "which," as being perfectly equivalent in sense, then it is a *relative*, and must be treated as such; but otherwise it is a *conjunction*, and must be translated not by *qui*, the Latin relative, but by the Latin conjunction *quod*, or *ut*, and sometimes by the accusative of the noun before the infinitive mood—as in *gaudeo te valere*, or *gaudeo ut vales*, or *quod valeas*, I rejoice that you are well; but when *that* means *in order* that, *ut* with the subjunctive is to be used—as *Te mitto, ut id feras mihi*, I send you to carry that for me.

Rule 5.—The *case* of the relative is fixed not by the antecedent, but by its relation to its own clause, which is thus treated as a separate sentence—as in *Arbores seret diligens agricola, quarum adspiciet baccam ipse nunquam*, the industrious husbandman will plant trees, the berry of which he will never see. Now here, although the relative *quarum* is the *feminine* gender, in agreement or concord with its antecedent *arbores* (*quarum arborum*), yet it is not the accusative case in agreement with *arbores* (plur. acc.), governed by *seret*, but it is the genitive case governed by *baccam*, and is in the genitive of possession.

VOCABULARY (of words not before given).

Qualis, such as (quality), relative to antecedent *talis* (such).
Quantus, so great as (quantity), relative to antecedent *tantus* (so great).
(These follow the same rules as *qui*.)
Præstare fidem, to keep one's word; *fidem fallere*, to break one's word.
Multa mentiri, to utter many lies; *contra officium est*, it is a breach of duty.
Circumfundi mari, to be washed by the sea.

Exercise.

Translate into English:—

Domicilia conjuncta, quas urbes dicimus. Levis est animi, justam gloriam, qui est fructus veræ virtutis honestissimus repudiare. Ego qui te confirmo, ipse me non possum. Nullum animal quod sanguinem habet, sine corde esse potest. Peroratio, qui epilogus dicitur. Talis est, qualis semper fuit. Regula utilitatis eadem est quæ honoris. Thebæ, quod Bœotiæ caput est. Mentiri contra officium est, id quod nulli honesti agunt. Multæ civitates a Cyro defecerunt, id quod bellum atrocissimum genuit. Talis est quæcunque respublica qualis ejus aut natura aut voluntas qui illam regit. Videre mihi videor tantam dominationem quanta nunquam antea fuit. Hoc bellum præsens est quale nulla barbaria gessit. Eo magis Herodotus Thucydidesque mirabiles, quorum ætas in eorum tempus, quos nominavi incidit Lacedæmonii regem, quod nunquam antea apud eos acciderat necaverant. Pax ita convenerat ut Etruscis Latinis fluvius Albula, quam nunc Tiberim vocant, finis esset. Est locus in carcere, quod Tullianum appellatur, circiter duodecim pedes humi depressus. Di favent pietati fideique hominum, per quæ populus Romanus ad tantum fastigium gloriæ venit. Pomptinus a te tractatus est præstanti ac singulari fide, cujus tui beneficii sum ego testis.

Translate into Latin:—

He kept his word, which all good men do. He is not such (quality) a poet as Virgil. The waves of the sea are such (quantity) as were never before seen by mortal eye. No trees, which bear fruit, can be useless to the husbandman. What (*i.e.* that which) is rightly deserving of praise. Many plant trees, the fruit of which they cannot see before their death. It is a breach of duty to lie, which thieves generally do. I have received the many pleasant letters which you have sent me. I have as much pleasure as you have in all these matters. Beasts do not generally move from the place in which they have been born. He is the same kind friend that he always was to me. He is admiring those peopled fires which we call stars. This island of ours is washed on all sides by the sea. You tell lies and break your word, both which things are injurious to your character (*mores*). To tell lies and to break one's word, that avoid as the height of folly (say the highest folly, and use *summus*). Cicero, the consul, preserved the city which held the dearest of all. The nests, which you have found on the trees, are all small, and empty of birds. The queen had a daughter whom she loved very dearly, although she was not what she ought to have been as a daughter. I praise you, who (use *quippe qui*) have slain the enemies of your country. I have accepted the very beautiful crowns which the slaves have now brought to me. The king has praised me with many words and a grateful merit, who had fought many battles for my country and had always kept my word. I, who praise this man, whom they call a consul, am also praised by all, a circumstance which is very pleasing to me, and others. I have restored all the gifts that I have received. The books that you read are written by very wise and learned men.

Questions for Self-Examination.

What is the third concord? What do you mean by the antecedent and what by the relative? What is always the position of the relative in Latin and in English? Learn off and write out the rules here given for the third concord. Mention words of a relative character which follow the rules here laid down for *qui*. Repeat the vocabulary, and write out sentences from it of your construction exemplifying the rules of the third concord. Show how the case of the relative is fixed. What rule do *qualis* and *quantus* follow? What are the various senses of "that"? When is it a relative? How treated when such? Give an example of the relative agreeing in gender with the predicate. Give an example of the relative referring to two or more antecedents and placed in the plural number.

BOTANY.

XXXV.

VARIOUS ORDERS.

IN connection with the Araliads we again learn how important it is in botany not to judge too hastily of an order from what we observe in a solitary and perhaps quite exceptional member. The familiar representative of the present family is the common ivy,—the peerless evergreen which drapes the aged forest tree and casts its glossy mantle over the ruins of castle and abbey. But in its habit, our English ivy is quite different from the great mass of the order, this consisting of shrubs and small trees which grow, like most others, independently. The agreement, as in other cases, is found in the flowers and the fruit, though in many cases there is a striking similarity also in the outline of the leaves. The species belong chiefly to the far east, and to temperate countries south of the equator, from which our English greenhouses have received those most beautiful ornamental plants, the various species of *Aralia* proper, remarkable as they are, almost universally, for the elegance of their foliage. There are a few of herbaceous character, but these, likewise, have fine foliage; so that the order, as a whole, may be pronounced as supreme in respect of leaf. The "Angelica-tree," so called, of the gardens, has grand doubly pinnatifid leaves that measure four or five feet across; while those of the nearly hardy *Aralia Sieboldii*, from Japan, now becoming very common, are, when full grown, nearly twenty inches across. After all, there is not a better plant from which to study the technical characters than the ivy itself, the flowers coming out plentifully in October. They are pentamerous and pentandrous, with an inferior few-seeded ovary, which becomes, in due time, an almost globular black berry. Ivy is not, as commonly supposed, a *parasite*. It clings to the bark of trees, but it does not suck nourishment from them, deriving its sustenance from the earth, in which the roots are lodged, and, except under rare conditions, ceases to exist when its connection with the ground is severed. Deriving its food from the soil, of course it is not to be classed, either, with the "epiphytes." The true description of this most interesting plant is that which terms it an evergreen climbing shrub. So long as it can ascend, clinging to the tree or old wall by means of its holdfasts, it is content to go on growing, producing only shoots and leaves. Flowers are not developed until it reaches the top of the object to which it clings.

The Araliaceæ.

FIG. 190.
BUTTERFLY ORCHIS.

Then the pretty and honeyed clusters appear in thousands, furnishing a delightful bouquet to the bees, and giving a new feature of floral beauty to the autumn. Very little of economic value is supplied by the Araliaceæ. The delicate material employed in works of art under the name of "rice-paper" is prepared from the pith of the stems of one of the species inhabiting Japan; and one or two have some kind of repute in oriental and American medicine; but service of any importance is not rendered. We can well afford to dispense with the economic, since the loveliness of the country is so exquisitely enhanced by the never-failing friend of the crumbling arch and storied window of the overthrown work of the Plantagenet builder.

That "rare old plant, the ivy green," reminds one always of another of the inestimables—old England's shining holly, at Christmas-time so gay with its scarlet bracelets. This plant is the English representative of a family which again in all Europe possesses no other, the species belonging chiefly to distant and often to trans-equatorial countries. When, however, among the Aquifoliaceæ, we are not perplexed by any contrast so prodigious as that which is presented by ivy and the arborescent Aralias, the Aquifoliaceæ being in every instance erect shrubs or trees, the latter sometimes attaining considerable altitude. Very few of them, however, are cared for, even by cultivators of rare and curious plants; and the idea of the family has to be gleaned, as fairly as may be, from our solitary native species. The wonderful changeableness of the common English holly is well known, some of the varieties having the leaves dappled with yellow or cream-colour, whence they are called silver-edged and golden-edged; while others are nearly devoid of prickles, or, more strangely yet, so thickly beset that they have the name of hedgehog hollies. There is variety also in the colour of the berries, which are sometimes, instead of red, a clear deep yellow. Several other species are in cultivation, but none surpass, even if they are equal to, the "ancient Briton," the veritable *Ilex Aquifolium*. The flowers, throughout the family, are small and inconspicuous, except when noticeable through their abundance. They are tetramerous or pentamerous, the stamens corresponding, and all have a solitary and superior ovary. The leaves are alternate, simple and undivided, and destitute of stipules. The important economic plants of the order are the tall-growing hollies of Paraguay and other South American provinces, from which *maté* is prepared. This, as is well known, is the favourite stimulating beverage of the inhabitants of those parts of the world. It possesses very energetic properties, and is occasionally imported into England for the use of invalids to whom its peculiar virtues are adapted.

The Aquifoliaceæ.

After these families of trees and shrubs, it

is an agreeable change to look at one composed entirely of herbaceous plants, and renowned for the loveliness and the simple character of its flowers. The Primrose family, moreover, is one of those which have their maximum in northern temperate latitudes, and is thus represented freely in our own island. The meadows, in many parts, teem with cowslips; the primrose itself is scattered almost as profusely as the daisy. Under the shadow of the trees, and in marshy ground, there are various pretty species of loosestrife; and in the corn-fields we find the scarlet pimpernel or shepherd's weather-glass, so called from its extreme sensitiveness to the changes of the sky. Every garden is enlivened similarly by the polyanthus, the auricula, and the Virginian shooting-star; and every conservatory by the beautiful cyclamen and Chinese primula. Many of the prettiest of this family come from the mountains; the Alps, the Caucasus, and the Himalayahs, contributing each their quota. The technical characters are easily learned. The flowers are almost invariably pentamerous; the corolla is always regular and monopetalous; the stamens are epipetalous, and placed *against* the petals, instead of alternately with them, as usual; the ovary is superior, and the ovules are attached, as in the Caryophyllaceæ, to a free central placenta. Charm of complexion and delightful odour being the special characteristics of the flowers in this family, there remains but little to say of their use, so far as regards direct and physical service. Indeed, after cowslip-wine and primrose-vinegar, it is scarcely possible to name a species that possesses economic repute; for the day is gone by for faith in the marvellous healing powers ascribed to many of the species, as also to countless other plants, by our forefathers, whose trust in them is illustrated in the most amusing manner in the writings of the old herbalists, especially those of the Elizabethan times. "Loose-strife," for instance, was considered a reconciler of men who had been so foolish and so wasteful of their time as to quarrel. In one sense the sweet old wild-flower is entitled to its reputation. Perhaps the fable was intended to teach that men who go to pure nature for their recreation find their days and hours filled so delightfully with ideas, and are so inspired with zest for the understanding of the beautiful, that they positively have no leisure left for enmity, for envy, hatred, and malice, wanting every moment for their invigorating pursuit,—the study of wild nature being in truth the *elixir vitæ* so passionately desired by all mankind, overlooked though it be by the majority,—this perhaps because wild nature is so near, and so "common," and given without charge.

The Primulaceæ.

FIG. 191.—LOOSE-STRIFE.

FIG. 192.—HONEYSUCKLE. GUELDER ROSE.

The herald of this lovely family is the common forget-me-not; contemplating which, one soon perceives that, like the Primulaceæ, it is marked by simple pentamerous and monopetalous flowers, with five epipetalous stamens. But how great the contrast presented in the fruit! Here, instead of a many-seeded capsule, we have a four-lobed ovary, strikingly similar to that of the Labiatæ, and which, when ripe, breaks up, as in the Labiates, into four apparently naked seeds. Now and then, as in the Echiums, there is a tendency also to irregularity of corolla; while the inflorescence is very often circinate, or incurved—a circumstance quite unknown in the primrose and cowslip group. An interesting positive feature is found also in the large predominance in the Boraginaceæ of *blue*, a colour we have several times had occasion to mention as totally absent even in some of the largest families. Upon this it follows that the Boraginaceæ must not be looked to for *fragrance* of blossom, since by one of those curious coincidences in nature which still await interpretation, blue and scentlessness are very generally associated, while, upon the other hand, whiteness quite as often implies perfume. No doubt it would be easy to cite examples of scented blue flowers and of scentless white ones, but the rule is the reverse of this. No trees or shrubs occur among the Boraginaceæ proper. The leaves are invariably alternate, simple and undivided, and exstipulate. They are often rough with strong hairs and bristles, which extend to the inflorescence, and when slightly magnified present very novel and elegant objects. Upon the leaves of different species of Symphytum the base of the long white horn-like hair is surrounded by what seems a heap of fairy pearls. Many a long evening's delight with the microscope is found without going beyond the frontiers of the Boraginaceæ. Like the Primulaceæ, the plants of this order belong chiefly to northern temperate latitudes, creeping, in many instances, far up the mountain sides. Like the Primulaceæ, also, they have outposts upon the seashore. Renowned for the beauty of their flowers, especially those in which azure prevails—the forget-me-not, to wit—they have little to offer of economic value. The plant which occupies the post of honour in this respect is the common borage itself, so valuable where bees are kept, and at the same time so remarkable in giving scarcely any indication of the presence of honey; while in other plants which the bees do not care for, or at all events do not visit—the crown-imperial, for example—it hangs in large liquid drops. Bees seem to prefer to suck quietly and gently. An ocean of nectar is less loved by them than a quiet little repository. They

The Boraginaceæ.

prefer the substantial and healthful recompense of industry during the livelong day to a sudden snatch of wealth such as too often is the beginning of ruin.

The Jasminaceæ.

The familiar and fragrant white jessamine or jasmine of the south of Europe gives its name to a family of very elegant little shrubs, noted for the beauty of their flowers, and usually, as in the common white, for the perfume which these exhale. This is referred to in the original name, which is oriental as to birthplace, and literally translated signifies "odour." No herbacous plants, and only a very few small trees, occur in this order, and though ligneous, its members can never be called robust. Slender twigs, which give to the plant a certain air of fragility, are the usual characteristic. The leaves are usually either trifoliolate or pinnate. The flowers are monopetalous, usually five-lobed, the lobes of the calyx corresponding. The stamens, singular to say, are seldom or never more than two in number—furnishing perhaps the only known example of a disproportion so remarkable as of two parts or organs to five. The tube of the corolla being long, the filaments adhere to the interior, and the anthers become epipetalous. The solitary and superior ovary becomes a little berry. The cooler parts of India contain the principal portion of the species, though several belong to China and to Persia. One of the most cheerful plants we now possess in England, for the winter decoration of the garden-wall, is the Chinese *Jasminum nudiflorum*, which begins to unfold its golden stars as early as November, and closes not till March. The specific name, nudiflorum, refers to the leaflessness of the twigs while covered with blossom, the foliage being in its pride during the summer. The common white jessamine, *Jasminum officinale*, thrives well even in towns, and forms a most delightful porch and gateway plant. No member of this family is deleterious.

The Oleaceæ.

In some respects the order just described so nearly agrees with the nobler one named after the olive-tree, that it has been proposed to consider them a unity. But while the Jasminaceæ are distinguished by the very curious feature of floral structure just mentioned, in the Oleaceæ there is an equally constant agreement as to proper tetramerous structure. Nothing gives a more admirable idea of an oleaceous plant than the common lilac-tree of every shrubbery and pleasure-ground. Mark the arborescent character,—a tree, without being colossal, or even adapted for use in the hands of the timber-merchant; the leaves opposite, simple, and undivided; the plentiful little blossoms, consisting of a four-lobed monopetalous corolla, a calyx to match, two epipetalous stamens, and a solitary and superior ovary, with long style and two stigmas. These plain and easily remembered characters are almost universal in the order, the only exceptions being that at times the perianth is undeveloped, as in the case of the ash-trees in their various kinds, the *Fraxinus excelsior* and others; and that now and then the leaves are pinnate. The flowers of the ash are the simplest found among exogenous plants of affinities so high. A tiny ovary and a couple of stamens constitute the entire fabric. Very interesting indeed are the members of this family, which, though not extensive, has the unaccustomed charm of reckoning among them one of the most illustrious trees in the world—the immemorial olive, to which it owes its designation. The olive, *Olea Europæa*, is a native of south-western Asia and some of the southern parts of Europe. The leaves resemble those of the evergreen oak, *Quercus ilex*. The little white flowers are the counterpart of those of the lilac, but instead of being produced in handsome thyrsi, they are close to the branches. The fruit is the famous olive of the Old Testament, and of the oldest secular poetry,—esteemed, however, not for eating, after the manner of grapes or apples, but as the source of olive-*oil*. Ordinarily in plants, oil, if present, is contained in the *seeds*: linseed oil, for instance, rapeseed oil, castor oil, almond oil, oil of Ben, and others. In the olive it is contained in the pericarp, furnishing perhaps the only known example of secretion in that particular part. Upon the enormous interest attaching to the olive-tree as an historical and emblematical one, we cannot here dwell. Much of the most elevated and inviting doctrine of the Christian faith is bound up with the olive as a representative or symbolical plant, and in every particular there is a conspicuously good good reason why it should be so. Perishing when the cold is too severe, having no desire for tropical heat, the olive is still one of the most easily pleased trees in the world, accommodating itself to the unkindliest of general conditions, bearing all things, yet never forgetting to be fruitful. The ash-tree, already named, is one of the most admired of our native trees. Commended by the old Roman poet Virgil, who bestows upon it the well-merited epithet *pulcherrima*, it is valued to the present day as indispensable wherever the object, in rural or ornamental planting, is a genuinely picturesque effect. All our large trees may be told by some distinct and prominent character. At every season of the year the ash is marked by the production of buds that are quite *black*—a circumstance nowhere else observable. The leaves of this glorious tree are pinnate, of about nine leaflets; but there is a curious variety in which they are simple, ovate in outline, and undivided. The ovaries ripen into the little brown samaras or "keys," which hang, in bunches so dense, upon the leafless branches all through the winter. Not upon every individual tree; for the ash, in addition to its other peculiarities, is remarkable among the Oleaceæ in having the flowers more or less unisexual. Trees upon which no clusters of fruit are developed produce flowers having stamens only, or in which the ovaries are at all events imperfect and abortive. Other very interesting plants of this order are the common privet, *Ligustrum vulgare*, the fringe-tree, the Forsythia, the Phillyreas, in their different kinds, and the manna-ash, *Ornus Europæa*, all more or less common in cultivation. The manna-ash is so

called from its exuding, in its native country, Calabria, a sweetish sap, which hardens to the consistency of cheese, and is supposed to resemble the miraculous "manna" given to the wanderers in the wilderness. It is possessed of slight medicinal properties, and for that reason is kept in the apothecaries' shops.

XXXIV.

The Preposition.

§ 211. Particles.
§ 212. Use of prepositions in place of inflexion.
§ 213. Simple prepositions.
§ 214. Compound prepositions, — formed from (1) comparatives, (2) double prepositions, (3) nouns, (4) adjectives, (5) verbs.

§ 211. Prepositions were originally *partieles*, words of one syllable; when, therefore, we find one or two syllables we may feel sure there is something in the history of that word to account for the form, either by ancient inflexion or by combination of words. *Particle* is not a word recognized among the classes of speech-division, but it is a convenient term for several little oft-recurring words, or *bits of speech*, which hang about among the more important members, and serve very necessary functions in joining them together, or determining their various shades of meaning, without possessing any definite character of class. Such a word is the negative *ne*, which was pointed out among the adverbs (§ 207 *b*). Such also are the words *of* and *to*, usually placed among the prepositions. Others have no independent existence, and will be considered as *suffixes* or *prefixes*.

§ 212. Prepositions have no inflexion; some of the simple prepositions help to supply the place of inflexion in other words now wanting it: *of* in the genitive of *nouns*. *for* and *to* in the dative (§ 153); also *to*, it will be remembered, is generally used with the infinitive of verbs (see § 177).

§ 213. Prepositions are (*a*) **Simple**, which may be reckoned within a dozen—

at	on
by (O.E. *be*, *bi*)	of, off
for	out (O.E. ût)
from, fro (O.E. fram, fra)	to
	up
in	with.

We find the old form of *by* in the compounds *betimes*, *beside*, *bestir;* in the latter word *be* has the force of *concerning*, *about*, which was the old sense of the word. The northern *ben* is a compound of *be-in* = by-in—

"Wi' kindly welcome Jenny brings him *ben*."
BURNS, *Cotter's Saturday Night*.

Fra is still in use in Scotland; *fro* we now seldom use, except in the expression *to and fro*, —"a raven which went forth *to and fro*" (Gen. viii. 7). *Off* is another form of *of*, and has taken part of its old sense, *from* or *away: e.g.*, Take it *off* the table, The ship stands *off* the shore. In the Bible *of* may still be read in this sense: "Whatsoever is more than these cometh *of* evil" (Matt. v. 37); it is also frequently read in the sense of *by*, an instrumental sense: "I have need to be baptized *of* thee;" "Jesus was led up *of* the Spirit" (Matt. iii. 14, iv. 1). The old form of *out* has been preserved in the adjectives *ut*ter and *ut*most: see § 170 (3). In middle English and in the northern dialect *to* was *til*,—

"The wind it blew *fra* north to south,
It blew *intil* the floor, O."
Old Scotch ballad.

In the form of *too* we use the word as an adverb. *With* formerly signified against, as in *with-stand; with-draw* has something of the same sense. *Mid* was employed in O. Eng. for the present sense *of with*.

Through, from the Old Eng. *thurh*, is called by some grammarians a simple preposition. Dr. Morris finds in it the remains of an ancient compound. *Down* is now a simple word, but is really a broken-down compound of preposition and noun: *of-dun*, *a-dun*, i.e. a-down; *dun* was O. E. for down or hill; thus *a-down* meant *off the hill*, the opposite to *up*, and as it came more into use the prefix dropped away and left nothing but the old noun with its separate sense as preposition.

§ 214. (*b*) **Compound** prepositions are words formed, like adverbs, from other parts of speech, or from one or more prepositions themselves. Thus we have—(1) Three which come from a time when *prepositions* had a tendency to be *compared*, like adverbs; for they contain the comparative ending *er* or *ter:* these are *after* (from *af=from*), *over* (from of=up; this word also goes to form *above*), and *under* (from *in*). *From* ought to be considered with these, because the *m* is a sign of an old superlative added to the simple (or positive) *fro*, which it has now nearly displaced.

(2) Formed from *prepositions joined to prepositions*, we have *but* (from *be-out*), *about* (from *on-be-out;* as we saw with adverbs, § 208, *on* of Middle English has fallen to *a*), *above* (from *on-be-of* or *ove*); and others not so closely amalgamated, as *unto*, *into*, *before*, *beneath*, *within*, *throughout*, and a few more.

(3) Formed from *nouns* are *again*, *among* (from *on-mong—mong* means mixing—see adverbs in § 205 (1) *a*), *across*, *adown*, *beside*, *inside*, besides a number of phrases used as prepositions, as *instead of*, *abreast of*, *on behalf of*, *by way of*, and numerous others.

(4) Formed from *adjectives* are *amid* (from *on-mid*, adjective), *below*, *around*, *anent* (from *on-efn*, O. E. adj. *efn*, near), *between* (i.e. *by-twain*), *along*, *since* (from Old Eng. *sith-than*, later than; afterwards *sith-then*, *sithens*, *sithence*).

There are two words *along:* the one, signifying *by the length of*, as in "I walk *along* the river," has gone through several forms besides *an-long* or *on-long*; the Old Eng. form was *and lang*. The second, meaning *on account of*, had for its original *ge-lang*; the use of this word is now accounted a vulgarism, probably

from confusion with the first. Ex.: "But if it is *along on* me" (Gower, quoted by Morris, *Lessons*, 193). 'Twas *along of* her as I did it, It's all *along of* him, are phrases frequently used among the common people.

Belonging to the prepositions derived from adjectives or adverbs, though not compounds, are the two *ere* and *or* = *before*, the Mid. Eng. forms of which were *er*, *are*, *ar*, Old Eng. *ær*. *Ere* is sometimes used in poetry:—

"*Ere* on my bed my limbs I lay."
COLERIDGE, *Child's hymn.*

Or has gone out of use, but occurs in the Bible:

"*Or* ever the silver cord be loosed, or the golden bowl be broken, or the pitcher be broken at the fountain, or the wheel broken at the cistern."—Eccles. xii. 6.
Here the first *or* is a preposition, the three others are conjunctions.

(5) Formed from *verbs* are *owing-to*, *notwithstanding*, *concerning*, *except*, *save*, *according to*, *respecting*, etc. *Except* is sometimes a conjunction (see § 199); it is a preposition in "He took all the apples *except* two."

Prepositions deserve careful study; upon a correct use of them depend many of the finer shades of meaning, and some of the peculiarities of the language. This frequently causes difficulty to the foreigner. An Englishman, too, learning another language, finds the correct employment of the small prepositions not easy to acquire; in both cases the learner has to depend on his memory only for that which the native knows by custom and ear. Even in English errors are sometimes made owing to uncertainty as to the usage after certain verbs. A list of special phrases will be given further on, under *Syntax*.

XXXIII.

PLATINUM.

THIS comparatively rare metal was originally brought from America; and the name platinum is, no doubt, derived from *plata*, the Spanish word for silver, on account of its supposed resemblance to that metal. Platinum has since been discovered in the Ural Mountains, and in other parts of the world. Platinum is generally found alloyed with other metals, all of which are, however, of rare occurrence. This metal, like gold, would appear to have a superior affinity for chlorine to oxygen, and may be attacked by aqua regia. This acid, indeed, was formerly employed to obtain platinum in the metallic form. The ore being dissolved in this liquid, on the addition of the salt known as sal-ammoniac a precipitate was obtained, consisting of an insoluble chloride of ammonium and platinum. On heating, the ammonium chloride was driven off, and the residuum consisted of a mass of metallic platinum, in a finely divided state, known as spongy platinum. Platinum, in this condition, possesses in a high degree the power of gaseous absorption, with effects that have already been pointed out. The mass of finely divided platinum thus obtained may be welded into a coherent solid at a high temperature. It will be seen, therefore, that platinum, although placed among the noble metals, possesses one at least of the essential characteristics of iron. A very useful alloy of platinum—harder indeed than the pure metal, and less easily attacked by acids—is obtained by exposing the ore to the intense heat of the oxy-hydrogen blowpipe, in a crucible of lime. The more volatile constituents of the compound being evolved in the gaseous state, or absorbed by the substance of the crucible, an alloy of platinum with the rare metals iridium and rhodium, present in the ore, will be found to remain. Another method of reducing platinum, in the pure state, is to mix the ore with that of lead—galena as it is termed—the whole being then subjected to the same high temperature as in the former case. An alloy of lead and platinum is thus obtained, and the platinum is finally liberated by the process of cupellation described under the head of silver.

Platinum found native.

Attributes of platinum.

Spongy platinum.

May be welded.

Alloy of platinum.

Platinum prepared by cupellation.

Platinum is a very heavy metal, its specific gravity being somewhat greater than even that of gold. Platinum can be fused only at a very high temperature, and indeed was long regarded as infusible. In the present day, however, this result can easily be accomplished by the oxy-hydrogen blowpipe, and other means. Pure platinum is of a dull greyish-white colour, much less brilliant than silver. This metal is unattacked by the ordinary acids, but, like gold, dissolves in aqua regia, with the formation of a chloride. This power of resisting acids, together with its infusibility, causes it to be largely employed in the laboratory as a material for the manufacture of crucibles and other vessels. Platinum has no tendency to combine with oxygen in air either moist or dry; two oxides of this metal can nevertheless be prepared by artificial means—a monoxide and a dioxide. These compounds do not, however, present any features of interest. Platinum combines with chlorine to form a dichloride and a tetrachloride. The latter compound is prepared by dissolving platinum in aqua regia; on evaporation crystals of tetrachloride of platinum combined with hydrochloric acid separate out. Platinum tetrachloride, in combination with many of the alkaline chlorides, forms a series of double salts. Platinum dichloride, when acted upon by ammonia, is decomposed, the chlorine being evolved as a gas, while the metallic

Difficult of fusion.

Attacked by aqua regia.

Oxides of platinum.

Platinum and ammonia.

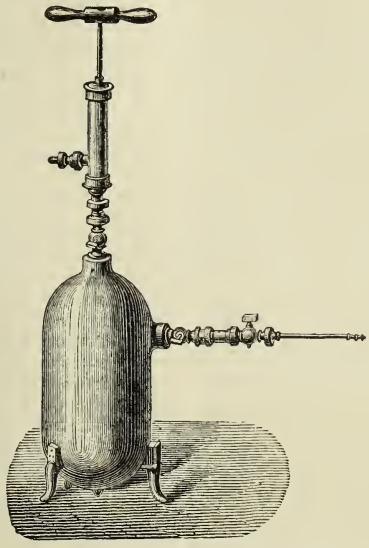
platinum combines with the ammonia, by displacing a portion of its hydrogen.

Of the metals with which platinum is generally found in combination—palladium, rhodium, iridium, osmium, and ruthenium—we shall say nothing, as they are of very rare occurrence, beyond drawing attention to the fact that a remarkable compound of the metal palladium and hydrogen was obtained by the late Mr. Graham, of the Mint. This did not consist of a mere occlusion of that gas similar to what takes place in the case of molten silver and oxygen, but was to all intents and purposes a true alloy, possessing all the attributes of a new metal. Medals stamped in this compound were exhibited at the last Paris exhibition. The strong inferential proof of the metallic nature of hydrogen thus afforded has been confirmed in a remarkable degree by the late experiments of Mr. Pictet, to which attention has already been drawn. We must therefore come to the conclusion that hydrogen is a substance of the same nature as the metals, but so volatile as to assume the condition of an invisible gas under normal conditions. Two new metals have quite recently been added to the series, by the method of research known as spectrum analysis, to which we are already indebted for other discoveries. This is in itself such a deeply interesting branch of physics, and opens such an illimitable field of possible future discovery, that we feel bound to give our readers some idea of its general nature.

Metals found combined with platinum.

Palladium and hydrogen.

Discovery of new metals.



OXYHYDROGEN BLOWPIPE.

Spectrum Analysis.

We have hitherto considered the art of the chemist as confined to the analysis and decomposition of the varied compound substances of which the world we inhabit is built up, and have shown that several elements may exist, bound together by the laws of chemical affinity, in the same body, and that the infinite variety of the material universe, inorganic as well as organic, is the result of the combination of a comparatively small number of elements. That science would, however, ever place within our reach the means of determining the chemical constitution of other worlds than our own—of that, for instance, of the mighty luminary of our system, the dispenser of light and heat, and therefore vitality, to the globe we inhabit—might well appear a dream, whose realization could never be hoped for by man. And yet not only is this an accomplished fact, but we are able to determine inferentially, with more or less accuracy, the constitution of the distant stars—those self-luminous bodies whose light travels to us from the infinite depths of space. The science by which we are enabled to determine such marvellous results is known as spectrum analysis—which, as its name indicates, is based upon a careful investigation of the solar spectrum or bright band of colours obtained by passing a ray of sunlight through a prism. The beautiful meteor with which we are all familiar in the rainbow is an example of the natural formation of a spectrum by the refraction of the sun's rays in the drops of rain.

Analysis of terrestrial compounds.

Analysis of the constituents of other worlds.

Derivation of the term spectrum analysis.

The spectrum due to refraction.

Before entering upon the subject of spectrum analysis, it is evident, therefore, that we must say a few words on the phenomena of refraction. The views that formerly prevailed in the scientific world with regard to the nature of light and heat have of late years undergone a very material modification. We no longer look upon light or heat as subtle impalpable fluids transmitted by light or heat-giving bodies, but we regard them as a condition of matter thrown into a state of undulatory or vibratory motion. It is clear, therefore, that neither light nor heat can have any independent existence apart from matter. What has already been said of heat is equally applicable to light, and the laws governing both these manifestations of natural energy have a counterpart in those of sound. The bell quivering under the stroke of the hammer, or the harp string vibrating with the motion imparted to it by the finger, transmit their undulations to the surrounding atmosphere just as the pebble dropped into the middle of a pool of still water throws it into a series of ring-like waves. The tone or pitch of sound depends on the rapidity with which these undulations succeed one another. A deep or bass note is due to the waves of sound reaching our ears more slowly—that is to say, at longer intervals than those that give rise to shrill or high-pitched sounds. In the one case while we speak of them as waves, in the other we may more aptly term them ripples. Although the transmission of sound is infinitely slow as compared with the lightning pace at which light travels, yet the whole of the phenomena of

Theories regarding the nature of light.

Analogy of the phenomena of light and sound.

Pitch of sound due to rate of undulation.

sound may fairly be compared with those of light. The various rates of undulatory transmission in the case of light affect our organs of sight with a sense of colour. Thus colour is to light what pitch is to sound. The slowest vibrations or waves of light give rise to the sense of red, while the more rapid undulations or ripples of light induce that of blue or violet.

Colour in light analogous to pitch in sound.

Before going any further, we may take the opportunity of remarking that the early advocates of the undulatory theory of light were confronted with the difficulty of accounting for the transmission of light through the regions of space lying beyond the atmosphere of our globe, and which, up to that time, had been regarded as absolute vacuity. The opponents of the theory argued that as sound cannot be heard in vacua, or in any enclosed space from which the air has been withdrawn, light, if due to material undulations, could not be transmitted to us from the sun through a perfect vacuum. This is of course undeniable, and if space can be shown to be absolute vacuity we must perforce relinquish the undulatory hypothesis. But the question at once suggests itself, Is space vacuity? In the sense of being filled with any material substance, similar to even the most rarefied, subtle and refined, with which we are acquainted, yes! In the sense of absolute nothingness, no! At the same time, it must be confessed that we know but little concerning the nature of the medium pervading space. It would appear—judging from the phenomena exhibited by light—to be susceptible of transmitting vibrations in a manner differing from the grosser media of our terrestrial universe. In addition to filling all space, we are bound to assume that this subtle fluid finds its way between the ultimate particles of the hardest and densest substances. Hence it is sometimes spoken of as interstitial, but more properly, as the medium of the transmission of light, as luminiferous ether. Of its real nature we know nothing, but the existence of such a medium is assumed in order to account for the propagation of light and heat through space in accordance with the, now universally received, undulatory theory.

Transmission of light through space.

Demands a medium of transmission.

Is space vacuity?

Interstitial or luminiferous ether.

KEY TO FRENCH EXERCISES—VII.

EXERCISE XXXIII. (*vol.* ii. *page* 7).

1. Elle finira ; elle finit ; elle finissait ; finissons-nous ? 2. Je vous punis ; vous me punirez ; tu les punissais ; l'as-tu puni ? 3. Il saisit une arme et franchit la tranchée ; saisit-il une arme et franchit-il la tranchée ? 4. Vous m'éblouissez avec vos armes et votre devise. 5. La lumière les éblouit; la lumière les éblouit-elle ? 6. Les lettres et les lumières périront ; les lettres et les lumières périront-elles ? 7. Nos neveux gémiront ; pourquoi gémiront-ils ? 8. Ses deux neveux ont péri à la Chine. 9. Ma lunette grossit beaucoup les objets ; votre lunette grossit-elle beaucoup les objets ? 10. Vous ternissez mes lunettes ; vous ne les ternissez pas ; les ternissez-vous ? 11. Ils gémissent dans les fers. 12. Il brandissait son épée ; vous les brandissiez. 13. Ils le saisirent à la veille des vacances. 14. La franchise ne bannit pas le savoir-vivre. 15. Prospéro punit-il Caliban ? le punissait-il ? 16. Mon pauvre garçon, la fille aînée t'aura ébloui par ses lumières, et la cadette par ses charmes. 17. Ils ne réussiront pas à préserver leurs franchises. 18. Le faste et les honneurs ont réussi à le guérir. 19. Son frère puîné trahit sa patrie, et périt sur l'échafaud. 20. Est-ce que j'unis (*more euphonic than* unis-je ?) unissais-je ? unirai-je ? ai-je uni ?

EXERCISE XXXIV. (*page* 70).

1. Dix-sept, cent soixante-dix-sept, quinze, cinq cent cinquante, cent quatre-vingt-treize, mille neuf, onze mille un, mille (*if a date write* mil) huit cent quatre-vingt-un. 2. L'année bissextile a trois cent soixante-six jours. 3. Dans notre jardin il y a vingt grands arbres. 4. Avril a-t-il trente ou trente et un jours ? il en a trente. 5. La terre tourne une fois sur elle-même en vingt-trois jours, cinquante-six minutes et quatre secondes. 6. La vérité est une. 7. Neuf cent quatre-vingt-dix-neuf s'écrit par trois neuf. 8. Ce livre a trois cents pages. 9. Vous le trouverez à la page quatre-vingt. 10. Je franchirais le ruisseau deux ou trois fois. 11. Qu'ils gravissent la colline deux par deux, ou trois par trois. 12. Qu'ils marchent quatre à quatre ou cinq à cinq. 13. Une pièce de cinq francs au millésime de mil huit cent quarante. 14. J'aurais fini les *Mille et une nuits* si vous n'aviez pas caché le livre. 15. Les *Mille et un jours* est le nom d'un recueil de contes persans. 16. Ils croyaient que le monde périrait en l'an mil. 17. Ils ont observé le passage de Vénus en mil huit cent soixante-quatorze ; je voudrais qu'ils l'observassent de nouveau en mil huit cent quatre-vingt-deux. 18. Combien y a-t-il de Londres à Edimbourg par le chemin de fer ? Il y a environ quatre cents milles. 19. Charlemagne fut couronné empereur à Rome, en l'an huit cent. 20. Le moyen âge embrasse la période comprise entre la chute de l'empire romain en quatre cent soixante-quinze, et la chute de Constantinople en mil quatre cent cinquante-trois.

EXERCISE XXXV. (*pages* 100, 138).

1. Catherine II., empress of all the Russias, was one of the first authors of the partition of Poland; Frederick II., king of Prussia, and Maria-Theresa of Austria were the other two. 2. Reason partakes of the nature of truth : it is one; you reach it by one road only, and one wanders away from it by a thousand. 3. The

twenty-fifth anniversary of a wedding is sometimes called silver wedding, the fiftieth is called golden wedding; one speaks also of a diamond wedding; this takes place ten years after the golden wedding. 4. Strict quarantine is for forty days. 5. In speaking of things that one buys, one says, *un cent* of faggots, of eggs, of plums, of apples, etc.; contrariwise one says, *une centaine* of men, of horses, of workmen, etc. 6. Malesherbes perished on the revolutionary scaffold on the 22nd April, 1794, being seventy-three years old. A monument was erected in 1819 in the large hall of the Palace of Justice (law courts) in Paris, to the memory of that noble judge; it bears a Latin inscription which is attributed to King Louis XVIII. 7. A painter by the dozen is an artist who produces much and badly. 8. The first book bearing a date was printed in Strasbourg, in 1457. 9. Charles VII. had made his son (Louis XI.) marry Margaret Stuart of Scotland, that charming princess who took so keen a liking for the French language and literature, that finding one day the poet Alain Chartier asleep on a bench, she kissed him on the forehead, in presence of her retinue very much astonished, for he was very ugly. 10. Felix Peretti was raised in 1585 to the sovereign pontificate, under the name of Sixtus V.

EXERCISE XXXVI. (*page* 138).

1. Nous passerons la semaine sainte à Rome. 2. Il passe ses vacances à Londres. 3. Au point du jour ils passeront par Paris. 4. Venir comme mars en carême veut dire en français venir inévitablement. 5. Chercher midi à quatorze heures veut dire en français chercher des difficultés où il n'y en a pas. 6. Cet homme cherche midi à quatorze heures. 7. Elle passe son temps à admirer le lever et le coucher du soleil. 8. Nous avons trouvé des serviettes à dix-huit francs la douzaine, et des nappes à dix francs la pièce. 9. En premier lieu vous trouverez qu'Erasme avait manié tous les sujets auxquels Luther toucha, et en second lieu qu'il les mania en savant et non pas en apôtre. 10. Je désire qu'ils arrivent le premier ou le deux octobre. 11. Pourquoi n'arriveraient-ils pas le vingt et un septembre? 12. Ce livre a trois volumes: donnez-moi le deuxième. 13. Ils arriveront à Edimbourg le deux juillet. 14. Quel âge a votre grand-père? — Quel âge lui donneriez-vous?—Je lui donnerais quatre-vingts ou quatre-vingt-cinq ans. Eh bien, c'est un nonagénaire. 15. Et votre grand'mère?—Elle frise les soixante-dix ans. 16. Quelle heure est-il? Il est midi ou midi et quart; je n'en suis pas sûr, ma montre avance. 17. Louis onze avait trente-huit ans et résidait depuis cinq ans dans les états du duc de Bourgogne, quand, le vingt-cinq juillet mil quatre cent soixante et un, il apprit qu'il était roi de France. 18. Donnez le dix de cœur; ne jouez pas en atout. 19. François premier, Henri huit, Charles-Quint, et le pape Sixte-Quint étaient contemporains. 20. Les mérovingiens furent la première, les carlovingiens la deuxième, et les capétiens la troisième dynastie des rois de France.

EXERCISE XXXVII. (*page* 167).

Je vous punis; tu les punissais; il me punit; elle le punira. 2. Ce chien gémit toute la journée; il ne gémira pas toute la soirée. 3. Nous vous applaudissions; vous ne nous applaudirez pas; ils m'applaudiraient. 4. Il franchit la distance en quelques enjambées. 5. Me saisissez-vous? vous saisissaient-ils à la gorge? Le saisîmes-nous? la saisira-t-il? 6. Je le garnirais; je l'aurais garni; tu le garniras; tu ne l'auras pas garni. 7. Délivrons-la; ne la délivrons pas; délivrez-les; ne les délivrez pas. 8. Qu'il remplisse la cuve; qu'il ne la remplisse pas; qu'ils remplissent la charette. 9. Je désire que vous me bâtissiez une maison; je désirerais qu'ils bâtissent des nids. 10. Une brassée de sarments ne remplira pas le four. 11. Je vous saisis le bras; saisissez-moi le bras; ne me saisissez pas le bras; le chien lui saisissait la jambe. 12. Je finissais ma journée; tu ne finissais pas ta journée. 13. Nous vous garantissons cette montre pour deux ans; vous lui garantissez un grand succès. 14. Il la finit en trois cuillerées. 15. Vous ne lui remplirez pas l'assiette; lui remplirez-vous l'assiette? 16. Vous leur fournirez deux charettées de foin. 17. Elle vieillira avec lui; vous rajeunissez tous les jours. 18. Finissez cette bouchée de pâté; ne finissez pas cette gorgée de vin. 19. Il périt dans l'année comme son père avait péri avant lui. 20. Les oiseaux les nourrissent—les oiseaux leur donnent la becquée.

EXERCISE XXXVIII. (*page* 167).

1. Is it to me you are speaking? Yes, and I was begging you not to interrupt me. 2. Did you tell him that we are setting out immediately? Yes, sir, and he begs you to have the kindness of waiting for him. 3. Art thou still fond of reading? Yes, madam, when I do not work I always read to amuse myself. 4. Has she just written to them? She has given me her letter to read. 5. Do you wish us to write to him (*or* her) or to speak to him? Do as you please (*lit.* as you will please). 6. What hast thou done to them? I have done nothing to them. 7. Must I obey him? Certainly, if he orders you only what is right and wise. 8. To whom shall I give them? Give them to Stephen. 9. What did Julia ask you? She asked me to accompany her as far as Geneva. 10. Dost thou not recognise me? No, I could not say who you are. 11. When did his sister leave him? She left him on the 6th of June last. 12. Call upon me as often as you can (*lit.* will be so able).

EXERCISE XXXIX. (*page* 168).

1. Voulez-vous que nous lui parlions? Oui, nous voulons que vous lui parliez. 2. Vous a-t-elle dit de partir immédiatement? Non, elle nous a dit de partir demain. 3. Où vous enverrons-nous? Envoyez-moi chez moi. 4. Voulez-vous qu'il l'achète dès demain? 5. Nous parle-t-il? Il ne nous parle jamais. 6. Antoine vous a-t-il fait lire ces lettres? Hélas! il m'a fait lire toutes ses lettres. 7.

Quand vous a-t-il demandé de le faire? Il m'a demandé de le faire ce matin à neuf heures. 8. Qu'est-ce que Lisette lui a demandé? Elle ne lui a rien demandé. 9. Vient-elle de les voir? Non, elle ne vient pas de les voir. 10. Comment t'aurions-nous reconnu? 11. Thomas vous traduisit cette brochure. 12. Quand sa sœur le quittera-t-elle? Elle ne le quittera pas avant la chandeleur.

EXERCISE XL. (*page* 243).

1. Ils reçoivent des pommes; ils ne recevaient pas de poires; reçurent-ils des prunes? ne recevront-ils pas de reines-Claude? 2. Tu recevras, dit-il, vingt et un abricots. 3. Vous avez reçu des brugnons et des pêches?—Moi? jamais. 4. Voici les fruits: toi, tu recevras toutes les amandes; elle recevra toutes les avelines; moi, je garderai toutes les châtaignes. 5. Je les apercevrais; je ne vous apercevrai pas; l'aperçois-je? *or* est-ce que je l'aperçois? 6. Qui aperçoit des groseilliers et des framboisiers?—Moi, *or* Moi, j'en aperçois. 7. Qui apercevra le premier des fruits sur ce cognassier?—Lui, *or* lui en apercevra le premier. 8. Apercevez-vous un néflier parmi ces noiscticrs? 9. Nous apercevions de temps en temps un pommier sauvage solitaire. 10. Il me doit; elle te devait; vous lui deviez; nous lui devrons. 11. Nous dûmes attendre. 12. Je devrai ma vie à lui ou à elle. 13. Ces dattiers et ces cocotiers doivent leur vigueur à mes soins. 14. Il nous reçut sous un châtaigner aux rameaux étendus *or* sous un châtaigner dont les rameaux s'étendaient au loin. 15. Tu les aperçois sous ces oliviers. 16. Votre père me doit beaucoup d'argent pour ces cerisiers et ces noyers. 17. Il nous aperçut derrière les groseilliers (à maquereau). 18. Je vous dois quelque chose.—A moi?—Oui. 19. Je veux qu'il conçoive des soupçons; je voudrais qu'il conçût des soupçons. 20. Vous me redevez vingt francs; Mathieu percevait les impôts; je ne les décevrais pas.

XXXI.

PERSIA (*continued*).

THIS prosperity continued during three reigns. Yezdijird I. reigned from 401-21. We know of him that he was inclined to allow the Christians in his dominions liberty of conscience. Toleration not being one of the tenets of the Persian religion, he became highly unpopular with the Magi in consequence.

Varahran V. was one of the bravest of Persian monarchs: his munificence and generosity were very great, although he is said by some historians to have persecuted the Christians with great rigour. He repelled the Turks of Trans-Oxiana.

PERSIAN WATER-CARRIERS.

The most powerful monarch of the Sassanian dynasty was Chosroes (called by Markham Naushirwân). The Romans, fearing his arms, purchased peace from him at the price of 11,000 pounds of gold; he received, besides, some of the spoils of Carthage, which had been taken by the Romans under Belisarius, in 533. The Roman arms being engaged in the west, Chosroes, by the advice of his friends, violated his treaty, and assembled an army against Rome. Several powerful cities bought their safety from him, for he was as avaricious as he was brave. He next turned his thoughts towards Palestine, and would have taken and sacked Jerusalem but for the presence in that city of Belisarius. The next year Chosroes, with a force of 4000 Persians, conquered a Roman army of 30,000 men, commanded by fifteen generals. He next undertook a Colchian war, which lasted some time. Rome and Persia finally

The most powerful Sassanian monarch.

Roman defeat.

agreed to keep the peace, though Chosroes insisted on an annual tribute of 30,000 pieces of gold, to be paid him by the former. The reign of Chosroes was highly beneficial to Persia. He was a patron of literature, and a wise ruler, and was deservedly called "The Just." The Magian religion was the established one of the country.

Hormuz, the son of Chosroes, lost all his father's conquests, and was defeated by the Romans in 586, after which he was put to death by his subjects in an insurrection. His son, Chosroes II. (or Khusru Parviz), asked assistance of Rome to quell the revolt. This was given, and the Romans in return received two important cities. Persia continued on good terms with Rome until the murder of Maurice, emperor of Rome, by Phocas. Chosroes swore to avenge his friend, and speedily defeated the Roman army in the East, taking possession of Syria. This encouraged the king to attempt

Insurrection in Persia.

the siege of Jerusalem, which was taken by assault in the year 614. Ninety thousand Christians were said to have been slaughtered. Zachariah the patriarch was carried off to Persia, and also a very precious relic, a piece of the true cross, which had been discovered by the empress Helena, mother of Constantine the Great. Chosroes next attacked Egypt, which succumbed to his power in the year 616. The power of Persia was now at its height, the kingdom having the same extent as in the time of Xerxes. Rome appeared to be enthralled by Persia at this time; but the emperor Heraclius, who succeeded to the throne in 610, was so enraged at the insolence of Chosroes that he became desperate, advanced on Persia, and penetrated to the very capital of the king, completely routing the Persian arms. Chosroes suddenly lost all nerve, and was placed in a dungeon by order of his son, where he died in

Siege of Jerusalem.

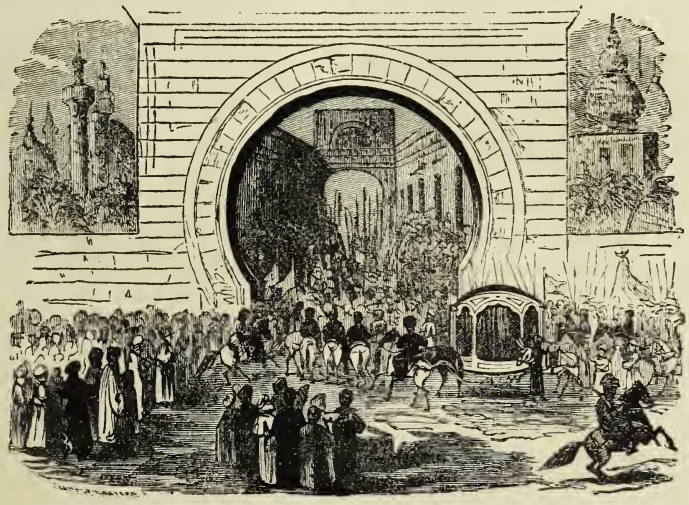
Power of Persia.

628. He had indulged in every kind of luxury and extravagance. Peace was now concluded with Rome, Heraclius stipulating that the wood of the true cross should be restored to him. This was done, and the relic was brought back to the Holy Sepulchre at Jerusalem with great pomp and ceremony. The Sassanian dynasty may be said to have ended here. A complete series of coins of the kings of this dynasty exists, showing the monarchs to have been of a very handsome Aryan type.

End of Sassanian dynasty.

When Chosroes was at the height of his prosperity he had received a letter from an unknown enthusiast named Mohammed, announcing himself as the prophet of God, and demanding to be recognized as such. To this the haughty king replied by tearing up the letter, or, as some say, casting it into the river, taking no further notice of the matter. Yet, not long after Chosroes' death, Mohammed had subjugated

Appearance of Mohammed.



BAGDAD IN ITS GLORY.

the whole of Arabia, and his successor, Abu-bekr, first caliph, advanced on Persia, conquered the country, and established Mohammedanism. The rule of the caliphs, beneficent on the whole, lasted two hundred years. When their power became weakened, several dynasties arose and tried to regain the country, but without success.

The Caliph rule.

In the year 936 Persia passed from Arabian to Turkish rule, which lasted until 1194. Some years after, a dynasty of shepherd kings, from the borders of the Caspian Sea, ruled in Persia; they were branches of the Turcomans, who had settled and become powerful in the country. In 1218 a new and terrible foe appeared in Persia, in the person of the hardy Moguls, under their great leader Zingis Khan. It was only in the reign of his grandson, Holagou Khan, however, that Persia finally succumbed to Mogul rule. The Moguls encouraged science and literature, which was all the more wonderful as they had

The Moguls.

but just relinquished savage life; and they were very tolerant in religion. Their successors had not the power or liberal views of Holagou and his son, and the people were inclined to welcome, instead of repel, the terrible Tamerlane, or Timur, the "Man of Iron," when he appeared in their country.

This great man was khan of Zatagai, and his capital was Samarcand, where his beautiful tomb of green marble may be seen to this day. His life was one long series of glorious conquests. Not only did he subdue Persia, but he invaded India and besieged Delhi; he ravaged East and West Tartary, and penetrated even into Russia, creating the greatest terror with his wild hordes of lawless foreigners. He completely subdued Persia, taking Bagdad, which had been made the capital under the Moguls; but, as he met with some little resistance in the outlying districts, his power was not fully established in the country until the year 1393.

Tamerlane's conquest of Persia.

MANAGEMENT MADE EASY.

BY THOMAS DUNMAN.

THE word "Tact" has its origin in a Latin word signifying "to touch," and it expresses that somewhat indefinable delicacy of mental and moral perception which some persons possess in a very high degree, and which is such an invaluable quality in all the relations of life.

The man of tact is of great use in the business world, and is sure to make his way in life. So many clerks and shopmen are mere machines, performing their daily round of work in a purely automatic manner, without in the least attempting to guide their hands by their heads, that it is quite refreshing to encounter an individual possessed of that ready tact which not only tells him *what* is to be done in given circumstances, but tells him also *how* it is to be done, and *when*. This faculty of business tact is one which, although invaluable, is easily acquired. It is only necessary to keep the eyes open and to carefully observe whatever comes beneath one's notice. We would earnestly counsel those of our readers who contemplate a business career to aim at being something more than mere machines. To a cheerful, willing, and zealous disposition should be added this important faculty of tact. During business hours the closest attention should be given, not only to the broad principles upon which business is conducted, but to every detail. Be fired with the noble ambition of being the very best man of business among your associates, and work steadily to realize your aim. We constantly hear complaints of the meagre remuneration which clerks and other business *employés* obtain, and there is a large amount of truth in the complaint. But look at many of such *employés* at their work. See in what a mechanical, unreasoning way they go about it, and how foolish and even idiotic are the blunders they make, and one cannot but confess that after all they are paid about as much as they are worth. The shrewd, clear-headed, business-man possessed of real tact and energy will always command a reasonable if not a good price, and those who wish to make their way in the business world must acquire a competent share of business tact.

But tact is also useful to the student. To know how and what to study is to solve half the problem of how to obtain knowledge, and the student should endeavour to look at every branch of knowledge in its relations to the career in life which he desires to carve out for himself. Do not be satisfied with studying something which strikes your fancy, but be sure that it is a subject for which you are fitted, and which will be of real assistance to you in your future career.

All persons differ among themselves as to their capacity, not only for knowledge in the abstract, but for different branches of knowledge. One person has a great taste for languages, and a distaste for mathematics; another has a strong inclination towards natural science, but abhors literature. The individual possessed of ordinary intelligence and of energy will be very unlikely to fail in any study which he takes up, but he is much more likely to obtain brilliant success in that branch for which he is especially adapted. It is here that tact comes in. To accurately gauge one's abilities and to estimate correctly one's chances of success in any particular branch of study requires considerable tact.

Perhaps the most important sphere for the exercise of tact is that of social life. A large number of persons seem, however, to be entirely destitute of it, and they consequently have the unfortunate knack of inflicting a large amount of pain upon their acquaintances and friends. Such persons invariably say the wrong thing upon every occasion, or say the right thing in the wrong place. Even if a compliment be intended, it is frequently conveyed in such a manner as to approach very nearly the character of an insult. Undoubtedly in such cases natural want of aptitude produces the unpleasant result, but it is impossible to entirely acquit the individuals themselves of serious blame. To blurt out unpleasant truths, and to express oneself in language which is liable to cause pain, argues a certain amount of moral as well as of mental obliquity; and it is the paramount duty of every one to guard against such a pernicious habit, or to keep altogether silent. In promiscuous company it is necessary to steer our course and feel our way with great skill and judgment if we would avoid wounding the susceptibilities of others; but the individual possessed of genuine tact can readily effect this, while the person destitute of that valuable quality will be sure to commit himself. In order to act with tact in such circumstances, it is necessary to keep thoroughly cool and retain possession of one's

faculties, otherwise a person who in the ordinary way possesses tact may be found deficient in it on an emergency. It is an unfortunate fact that a large number of persons in this world require "managing," and it is sometimes our duty as well as our interest to humour them—which of course can only be effected by the exercise of tact. How delicately some can, in such a case, touch the weak points in a man's character, how carefully his prejudices and antipathies are handled, and all this without deviating a hair's-breadth from the truth! And here it should be said that tact by no means implies the perversion or suppression of the truth; such a practice is diplomacy and chicanery incompatible with honesty.

But in action as well as in speech there is a necessity for the exercise of tact. Actions which may be in themselves perfectly justifiable, by being performed at unseasonable times become objectionable. On the other hand, a painful or distasteful duty which we may be compelled to perform loses much of its unpleasantness if the time of its performance be wisely chosen. In this, as in everything else where tact is valuable—and where is it not?—its exercise depends upon that extreme thoughtfulness and that consideration for the feelings of others which are implied in the character of a high-bred lady or gentleman—a character in which wealth or birth by no means necessarily form a part, but which is essentially cultured and refined.

In endeavouring to instruct others, or to impart information of any kind, tact is a valuable quality. Every one is at times called upon to give information upon matters with which he is acquainted, and this task may be much more pleasantly and satisfactorily performed by the exercise of a little tact. This is principally displayed in the skill with which self is kept out of the matter. Remember that it is your knowledge, and not your personality which is desired, and you will best effect your object by making the first personal pronoun subordinate to the third. It is also necessary to avoid assuming too much knowledge and giving yourself too great an air of superiority over the person who is seeking information. It is quite possible to maintain any necessary dignity without unpleasantly impressing others with your fancied superiority. The same necessity for tact exists in a supreme degree in the endeavour to warn or counsel others as to their conduct. If we are to be of any use in the world, and are to leave our mark behind us even in a humble way, it will occasionally be our duty to endeavour to persuade others to abandon vicious or mistaken courses, and to walk in the path of honour and integrity. In this, if in anything, tact is necessary; and yet how often it is conspicuous by its absence! The tracts and pamphlets that are so frequently thrust—with the best of intentions, no doubt—into the hands of the passenger in the street, are frequently very ill-timed. For the same reason well-meant endeavours to rescue the young from evil courses frequently terminate in failure or worse. Even to chide or counsel a bosom friend is a task requiring the utmost gentleness and tact, but to attempt the same with a stranger is a task infinitely more difficult, and one for which but few are qualified.

Tact is a very useful quality in debate of any kind; indeed, it may be regarded as the highest development of logic. To gauge accurately an adversary's powers, to adroitly parry his attacks, and to oppose him with skill, are the highest proofs of the possession of logical tact. This possession is one by no means to be despised. In the small as well as in the great affairs of life, the faculty of impressing upon others one's own view of a question or of a course of conduct is extremely useful and beneficial. The art of persuasion to which every one has frequent occasion to resort, is only a high development of tact, combining as it does the faculty of careful observation and adroit reasoning, with that skill in avoiding offence which is so rare an accomplishment.

There is a class of individuals the members of which despise tact, and look upon it as an absurd concession to the weaknesses of others. These are the "plain-spoken" people, the individuals who pride themselves upon always speaking their mind, and saying what they have to say without beating about the bush. The great objection to these individuals is that the plain-speaking is all on one side. Should you happen to pay them in their own coin, and to express yourself freely to them, they are extremely ready to take offence. As a matter of fact, their attitude towards others is the result either of gross conceit or of impenetrable stupidity, and their chief reason for objecting to the exercise of tact is that they feel themselves to be so immaculate that there can be no necessity for others to exercise it towards them. The blunt, clumsy individual who professes contempt for the feelings of others, may be, and often is, honest, but he cannot possibly be very wise. To employ tact is not only advisable—it is our duty. A due regard for the feelings of others is an essential feature in the Christian ideal, and to do what we have to do in the best possible manner is a duty as imperative as it is obvious. To speak out boldly when our principles are in question, or when we deem the truth to be imperilled, is our bounden duty, but at the same time we must remember that, as Solomon tells us, there is "a time to keep silence," as well as "a time to speak."

Undoubtedly the art of management is one which the greatest possible pains should be taken to acquire. We are all of us doing our best to succeed in the world, and success comes as a rule to those who, in the conduct of themselves and their affairs, manage best. There is such a thing as good fortune, but, in nine cases out of ten, what appears to be only the result of a happy chance is really due to dexterous management. Let us then study this art with all the zeal of which we are capable: who knows but that it may be more useful than all classical learning, or than the most profound acquaintance with science, in advancing us to positions of usefulness and influence?

ZOOLOGY.

IX.

MAN-LIKE MONKEYS (*continued*).—THE CHIMPANZEE.

THE Chimpanzee is perhaps the most widely distributed of all the great man-resemblers. His territory reaches from the banks of the Gambia to those of the Congo on the west coast of Africa, and the numbers of the species are very large. They associate together in troops, and are said to be armed with sticks. The human species they have naturally no great love for, giving the signal of man's approach in a cry as of intense distress. The adults are not by any means well known; they are rarely seen and much more rarely caught. Those that are captured do not usually live long. Undoubtedly many amusing and even human characters are exhibited by those chimpanzees which have been brought to England and lived under humanising influences, but these have all been young ones, very different in aspect, in habits, and in capability of being educated, from the adults.

In many respects the chimpanzee resembles the gorilla in structure, appearance, and habits; but when young, his muzzle is more prominent and ugly than the gorilla's, and his ears are much larger in proportion. He has very characteristic long black hair on the crown of the head, contrasting well with the white teeth; and there is a strange inferior-human expression about the face, which is almost hairless. The chin falls low and the shoulders are high, so that no neck can be seen in a front view. The body, for the most part, is clothed with long black hair, the chest is large, and not obviously marked off from the abdomen so as to form "a waist." Both soles and palms are destitute of hair, and very sensitive, and at the same time somewhat fleshy in colour. The upper limbs are very long, extending below the knee, and both they and the legs are well adapted for climbing. There is much less specialisation for walking, as is evident from the shortness and smallness of the calf.

Distinctions from gorilla.

We may say generally, that the young chimpanzee imitates the amusing and instinctive part of a child's performances, rather than the intelligent side: he shows powers of copying, of comprehending what amuses, and repeating the performance, and much of the caprice of the child; but in many things he does not nearly come up to the most highly educated dog. He can express satisfaction or the reverse by his voice, and bark or cry, but articulate speech cannot be acquired.

The young chimpanzee.

Mr. Broderip, that acute observer of nature, describes a young chimpanzee at the Zoological Gardens sitting child-like in the lap of his nurse and clinging to her. He looked mild and passive, like a little withered old man. He seemed quite to consider his nurse as occupying his mother's place. When not otherwise occupied, he would sit quietly in her lap, pulling his toes about with his fingers, for all the world like a human baby. Mr. Broderip tried to examine his teeth, and as his nurse made him lie back and tickled him to make him open his mouth, the resemblance was complete.

Mr. Broderip's studies.

The nurse had to leave him, and got away by offering him a peeled raw potato, which he ate with great relish. His keeper coming in, Tommy made an evident attempt to speak to him, achieving a hoarse "Hoo, hoo!" He wished to play, jumping up and down like a child, and showing an evident desire for a romp; and Mr. Broderip indulged him with a capital game.

His behaviour when a looking-glass was shown to him was strongly marked by wonder and astonishment. From the utmost activity he became immovably fixed, steadfastly gazing at the mirror with eagerness. The tips of Mr. Broderip's fingers appeared on one side as he held it. Tommy put his hands and then his lips to them, then looked behind the glass, and finally passed his hands behind it, to feel if there were anything substantial there. Notes were being made about him, so he came up and looked inquisitively, and tried the pencil with his teeth when given to him.

Tommy and the looking-glass.

The ape world and snakes must often come into contact, and it is doubtful how far the former can cope with the latter. Tommy was tried with a python placed in a basket with the lid open. He had been all gaiety and life; but he was suddenly taken aback, cautiously advanced to the basket, and then instantaneously recoiled from it, crying "Hoo, hoo!"

Tommy and a python.

Lieut. Sayers has given an interesting account of Bamboo, a young chimpanzee from Sierra Leone, who showed a strong affection for clothes, always seizing hold of any he came across. But he did not know how to put different garments on: he seated himself on his prize, which he would not resign without a hard fight, showing great anger. A piece of cotton cloth was given to him, and he ever after carried this about with him, never yielding to any temptation to part with it.

"Sayers' Bamboo."

Bamboo was fed at eight a.m. with a piece of bread about the size of a halfpenny loaf, soaked in water or milk-and-water. About two o'clock he got a couple of bananas or plantains; and at night a banana, orange, or piece of pine-apple. The banana was his favourite. Once, when one was refused him, he went into a most violent passion, cried out, and knocked his head forcibly against the wall, falling backwards with the blow. But he made no attempt to ill-treat his master or keeper.

Bamboo's food.

An endeavour was made to develop a companionship between Bamboo and two Patas monkeys, but he was always angry at their approach. He manifestly liked mankind and

hated all other races. He was, withal, remarkably cunning, stealing everything within reach, with no object beyond the pleasure of stealing; and he would never attempt to thieve when observed. He was very cleanly in his habits. He chose a washing-tub for a sleeping place, but always got up at sunrise and seated himself on the ledge of a window.

Bamboo's thefts.

It appears that the chimpanzee is of full age at about nine or ten years old. The bones of its brain-case very early become so soldered together that the brain cannot grow, and it remains somewhat smaller than the gorilla's. The skull, as the animal becomes full-aged, gains prominent crests, less marked than in the gorilla. The teeth are chiefly remarkable for the size of the front ones, or incisors, which have much to do with the aspect of the muzzle. The hip bones are still closer together than the gorilla's, because of the comparative narrowness of the united vertebræ (called sacrum) which form the wedge between them. The chimpanzee's bones and muscles are not really calculated to maintain the erect posture. The rudimentary tail-bones exist very much as in man.

Structure of chimpanzee.

With regard to the limbs, they are especially adapted to maintain a position the chimpanzee appears very fond of—namely, that of clinging to a branch by the hands with the whole body hanging therefrom. We meet with a transition to lower forms, for while in the gorilla the humerus (bone of the upper-arm) is longer than the two bones of the fore-arm, in the chimpanzee the bones are of equal length.

Limbs.

RHESUS MONKEY AND YOUNG.

The hand is large in proportion, but the thumb still smaller than the gorilla's: it does not assist in hanging on to a bar. In other respects we meet with transitions which connect this creature more with the monkeys and apes than the animals we have hitherto studied. The foot is more slender, more adapted for climbing than the gorilla's. The digits of all the limbs have flat nails. The toe-thumb is of much more use in climbing than the hand-thumb, taking an important part in grasping. There are great air-pouches communicating with the voice organ, but the chimpanzee is not credited with anything like so considerable powers of voice as the gorilla.

Hand.

Foot.

The Orang-Utan.

We now come to examine the "wild man of the woods" of Borneo and Sumatra, who cannot be dismissed with the simple remark that he is another of the great man-like apes. For he, in some respects, is more like man than the chimpanzee or the gorilla, while in others he is further removed. The great African apes have thirteen pairs of ribs, the orang but twelve; in shape the cerebral hemispheres, and also the shoulder-blades, resemble man's more than theirs. Yet both in the feet and in the fore-limbs there are distinctive characters sufficient to indicate wide separation from mankind. The fore-limbs are of huge relative length, reaching nearly to the ground when the animal is erect, the arm and fore-arm being about equal. The hind-limbs are only about half this length, and the feet naturally turn inwards, so that their walk is really upon the outer edge, with the sole proper turned inwards. But watch this creature in the thick continuous forests of the marshy plains of Borneo, with Mr. Wallace for our guide. "He walks deliberately along some of the larger branches, in the semi-erect attitude which the great length of his arms and the shortness of his legs cause him naturally to assume. He seems always to choose those branches which intermingle with an adjoining tree, on approaching which he stretches out his long arms, and, seizing the opposing boughs, grasps them together with both hands, seems to try their strength, and then deliberately swings himself across to the next branch. He never jumps or springs, or even appears to hurry himself, and yet manages to get along as quickly as a person can run through the forest beneath. The long and powerful arms are of the greatest use to the animal, enabling it to climb easily up the loftiest trees, to seize fruits and young leaves from slender boughs, and to gather leaves and branches with which to form its nest."

Distinctive characters.

Mode of locomotion.

The orang, says Mr. Wallace, feeds almost exclusively on fruits, particularly unripe ones. He is little alarmed at man's appearance, for he is immensely strong; he can even overcome the crocodile, being capable of actually pulling open its jaws; he can also master the python by a combined grip and bite.

Muscular power.

The extreme height of the skeletons of orangs that have reached Europe and been accurately measured is 4 ft. 2 in. The breadth between the tips of the outstretched arms has been found to be as much as 7 ft. 8 in. The width of the adult face, which is remarkable, varies from 10 to

Size.

13½ in. It also is very characteristic of the orang that the muzzle projects, in front of the eyes, for almost half the length of the head. The hair is long and reddish, the eyes and nose are small, the jaws very large, with large discoloured teeth. The brain-case and brain are very little more than half the size of an average man's; but in progress to adult age, the muscles of the head and jaws become of enormous bulk and power, and are attached to ridges that project and constitute conspicuous landmarks of bone.

External appearance.

The orang, when a baby, exhibits many features of resemblance to the human infant, especially in its sucking and screaming accomplishments. Mr. Wallace found that a little orphaned orang which he captured always cried when laid down by itself. When bathed it would make ridiculously wry faces while the stream was running over its head. It enjoyed amazingly being wiped and rubbed and having its hair brushed. Mr. Wallace at the same time had a young hare-lip monkey of about the same age; and he describes the little orang "like a very young baby, lying on its back quite helpless, rolling lazily from side to side, stretching out all four hands into the air, wishing to grasp something, but hardly able to guide its fingers to any definite object, and when dissatisfied opening wide its almost toothless mouth and expressing its wants by a most infantine scream; the little monkey, on the other hand, in constant motion, running and jumping about wherever it pleased, examining everything, seizing hold of the smallest objects with the greatest precision, balancing itself on the edge of the box or running up a post, and helping itself to anything eatable that came in its way." Thus we see how evidently the progress to a higher state in adult life is attended with a longer probation of helpless infancy.

A young orang.

GERMAN.

XXXVI.

Study on the Personal Pronouns, Reflective Pronouns, etc.

The Personal Pronouns are declined in the following manner (on the principle of the Latin *ego, mei, mihi, me*, etc.) :—

FIRST PERSON.

	Singular.	*Plural.*
Nom.	ich, I	wir, we
Gen.	meiner, of me	unſer, of us
Dat.	mir, to me	uns, to us
Acc.	mich, me	uns, us

SECOND PERSON.

Nom.	du, thou	ihr, you
Gen.	deiner, of thee	euer, of you
Dat.	dir, to thee	euch, to you
Acc.	dich, thee	euch, you

THIRD PERSON.

	Singular. Masculine.	Feminine.	Neuter.
Nom.	er, he	ſie, she	es, it
Gen.	ſeiner, of him	ihrer, of her	ſeiner, of it
Dat.	ihm, to him	ihr, to her	ihm, to it
Acc.	ihn, him	ſie, her	es, it

Plural.

Nom.	ſie, they
Gen.	ihrer, of them
Dat.	ihnen, to them
Acc.	ſie, them

For the reflective form, *myself* and *thyself, ourselves* and *yourselves*, in the genitive, dative, and accusative cases, the personal pronouns are used—as, Ihr denkt an Euch, ye think of
eer denkt an öich
yourselves; Ich vergeſſe mich nicht, I do not
ich fer-ges'-se mich nicht
forget myself. The plurals uns and euch have also sometimes a *reciprocal* meaning, synonymous with einander, *one another*. Thus, according to the context, Wir lieben uns may mean we love *ourselves*, or we love *one another* —like the French *nous nous aimons*. In the latter case the pronoun is reciprocal; in the former, the reflective case, the word ſelbſt is generally added: Wir lieben uns ſelbſt, we love one another; Ihr haſſet euch ſelbſt, you hate yourselves. For the third person there is a separate form in the reflective pronoun, thus:

	Singular. Masculine.	Feminine.
Nom.	——	——
Gen.	ſeiner, of himself	ihrer, of herself
Dat.	ſich, to himself	ſich, to herself
Acc.	ſich, himself	ſich, herself

	Singular. Neuter.	*Plural.* (All Genders.)
Nom.	——	——
Gen.	ſeiner, of itself	ihrer, of themselves
Dat.	ſich, to itself	ſich, to themselves
Acc.	ſich, itself	ſich, themselves

Examples; Er läßt ihm und ſich nicht Zeit, He does not leave him and himself time; Sie laſſen ſich überreden, They let them-
zee laſ'-sen sich ue-ber-ray'-den
selves be persuaded (literally *talked* over).

As things without life are not all neuter in German, but many are masculine or feminine, the corresponding gender of the pronoun must be used in the various cases—er, ſie, or es, according to the gender of the word. Thus—Wo iſt der Stock? Where is the stick? (masc.) Er ſteht in der Ecke, It (literally HE) stands in the corner: Haben Sie die große Birne geſehen? Ja, ſie hängt dort am Baume. Have you seen the great pear? Yes, it (literally SHE) hangs yonder on the tree. It must be remembered that the Germans only use the second person in addressing any familiar friend or near relative, or sometimes it is used by superiors to inferiors, by teachers to young scholars, like the French *tu;* for to *tutoyer* any one in French, or to duzen or call him *thou*
doo'-tsen
in German, is a token of familiarity. In the

great majority of cases, the third person form Sie is used; but when employed in addressing any one it is always begun with a capital letter. In writing, the pronoun for the person addressed is always written with a large initial. In old times the second person plural Ihr, like the English YOU, was the form of address between equals, and from inferiors to superiors, for singular and plural alike. Inferiors were addressed as Du. Thus Schiller, in his *Wilhelm Tell*, makes Tell address Gessler with the form Ihr, while the governor speaks to Tell as Du. The third person singular Er was also formerly used in addressing inferiors. Thus Frederick William I. and Frederick the Great of Prussia habitually addressed even courtiers and generals as Er. „Er ist ein Schmeichler, gehe er!" (You are a flatterer, you may go) was the first-mentioned king's reproof to an over-polite clergyman.

Where a personal pronoun representing an inanimate object or an abstract idea is to be used with a preposition, we generally in German employ the adverbial expression da or dar (there) instead of the pronoun; just as in English we had the old expressions therewith, thereupon, therein, for with it, upon it, in it. Thus, Der Wagen kam, und mein Freund saß darin (not in ihm), The carriage came, and my friend sat *in it* (therein); Der Schild war zu Schwer; er konnte damit nicht laufen, The shield was too heavy; he could not run with it (therewith).

EXERCISE ON THE PERSONAL PRONOUNS.

Haben Sie dieses schöne Buch schon
hah'-ben zee dee'-zes shoch'-ne booch shone
gelesen? Wenn nicht, so will ich es Ihnen
ge-lay'-zen venn nicht zo vill ich ess ee'-nen
leihen. Mir war es verliehen das Deutsche
ly'-en meer vahr ess fer-lee'-en dass doit'-she
Reich zu schützen sagte ein braver
rych tsoo shuet'-sen saach'-te ine brah'-ver
Kaiser nach einer gewonnenen Schlacht.
ky'-zer nach i'-ner ge-von'-ne-nen shlacht
Vergiß mein nicht ist der Name einer
fer-giss' mine nicht ist dare nah'-me i'-ner
kleinen blauen Blume. „Mit diesem
kly'-nen blough'-en bloo'-me mit dee'-zem
zweiten Pfeil durchschoß ich Euch, wenn ich
tsvi'-ten pfile dooreh-shoss' ich oich venn ich
mein liebes Kind getroffen hätte!„ sagte
mine lee'-bes kint ge-trof'-fen het'-te saach'-te
Tell zu Geßler. Ferdinand und Isa-
tell tsoo gess'-ler fairr'-dee-nand und ee'-zah-
bella von Spanien konnten sich
bel'-lah fon spah'-nien konn'-ten zich
darüber freuen, was er und sie für
dah-rue'-berr froi'-en vass airr und zee fuer
das Land gethan hatten. Ich sprach
dass land ge-tahn hat'-ten ich spraach
gestern mit Herrn Müller, aber er
guest'-ern mit hairrn muel'-ler ah'-ber airr
erinnerte sich meiner nicht. Ich konnte
er-inn'-er-te sich mine'-er nicht ich konn'-te
mich seiner wohl erinnern. Wir haben
mich zy'-ner vole er-in'-nern veer hah'-ben
uns einen frohen Tag gemacht, wir können
uns i'-nen fro'-en taach ge-macht veer kön'-nen
damit zufrieden seyn. Die Tasse ist
dah-mit' tsoo-free'-den zine dee tahs-se ist
zerbrochen; wir können nicht daraus
tser-bro'-chen veer kön'-nen nicht dah-rowss'
trinken. Sie hat ihm befohlen ihr die
trink'-en zee hat eem be-foal'-en eer dee
Wahrheit zu sagen. Wir können uns
vahr'-hite tsoo zah'-gen veer kön'-nen uns
diese Geheimnisse nicht erklären
dee'-ze ge-hime'-niss-e nich er-klairr'-en
Streitet euch nicht, ihr Kinder ihr sollt
stry'-tet oich nicht eer kind'-er eer zollt
gütig gegen einander seyn. „Wenn die
gue-tich gay'-gen i-nand'-er zine venn dee
Frist verstrichen ist, eh du mir zurück
frisst fer-strich'-en ist ay doo meer tsoo-rueck'
kommst, muß dein Freund statt deiner
kommst muss dine froind statt dine'-er
erblassen," sagte der Tyrann Dionys
er-blass'-en saach-te dare teer-ann' dee-o-niece'
zu Möros seinem Gefangenen. Das
tsoo moe'-ross zy'-nem ge-fang'-en-en dass
Mädchen hat einen guten Oheim; er
maid'-chen hat i'-nen goot'-en o'-hime airr
wird sich ihrer annehmen, Ihm kann ich
veert zich eer'-er an'-nay-men eem kann ich
diese schwierige Sache anvertrauen:
dee'-ze shveer'-ich-e zach'-e an'-ver-trow'-en
denn er bedenkt wohl was er thut.
denn airr be-denkt' vole vass airr toot
Lesen Sie uns diesen Aufsatz noch
lay'-zen zee uns dee'-zen owff'-zatz noch
einmal vor; wir werden Ihnen dankbar
ine'-mal fore veer ver'-den ee'-nen dank'-bar
seyn. In vielen Sachen ist die Erfahrung
zyne in feel'-en zach'-en ist dee er-fahr'-ung
uns eben so nützlich als die Klugheit.
uns ay'-ben zo nuetz'-lich als dee klooch'-hite
Ich bitte Sie, machen Sie mir nicht so
ich bit'-te zee mach'-en zee meer nicht zo
viele Einwendungen. Die Zwietracht muß
feel'-e ine'-ven-dung-en dee tsvee'-tracht muss
man vermeiden; sie bringt dem Menschen
man fer-my'-den zee bringt dame mensh'-en
Unglück.
un'-glück

X.

FRICTIONAL ELECTRICITY (*continued*).

A VERY important piece of apparatus for demonstrating the law of electrical attraction and repulsion is the *torsion electrometer*, already referred to in our description of Faraday's experiments upon dielectrics, and which is represented in fig. 35.

The torsion electrometer.

As will be seen, it consists of a cylindrical glass vessel, A A A A, about half way from the bottom of which is a circular band of paper, *a a*, upon which a scale, divided into 360 degrees, is marked. Upon the bottom of the glass case is placed a small dish containing chloride of calcium, which, by absorbing moisture readily, keeps the air in the interior of the vessel perfectly dry. Upon the top of the glass vessel a glass plate, B B, is placed, and is secured by three wooden buttons, *c c c*.

Upon the top of this glass lid, at its centre, is placed a tall cylinder, D, also of glass, but much smaller in diameter, and at the top of which is a *micrometer*, shown in section at the side. This latter consists of two cylindrical drums, the upper moving freely upon the lower. The lower one, A, is fastened with gum mastic upon the top of the glass cylinder, D D, while the upper movable one, B, bears a plate upon which a scale of 360° is marked. Through the centre of this plate passes a small rod, D D, which can be made to turn by means of the nut at its top, while a pointer, C, serves to mark upon the micrometer scale, in degrees, the rotation of the movable drum with respect to the fixed drum.

This micrometer being fixed upon D, a fine wire passes from the bottom of D into the larger cylinder, where it has attached to its other extremity a horizontally disposed rod of shell-lac, *f*, at one end of which is a gilt pith-ball, *g*. Finally, through the lid B B of the larger cylinder passes a stout wire, *f*, to the lower extremity of which another gilt ball is attached; the two balls, when the instrument is at rest, remaining in contact, and being opposite to the zero of the paper scale, *a a*.

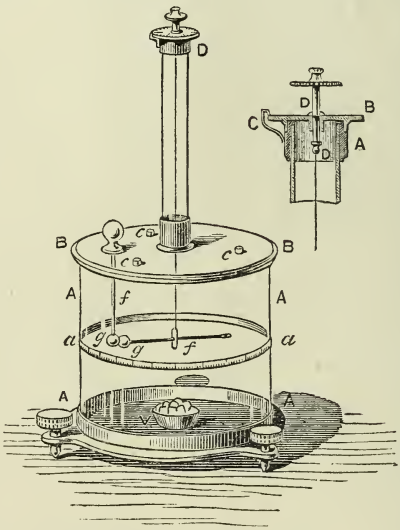


FIG. 35.—TORSION ELECTROMETER.

In using this apparatus, a charge from the body under examination is given to *f*, and this charge will of course be immediately conferred also upon the two pith balls, *g g*. These becoming thereby similarly electrified, will repel each other, and the shell-lac rod, *f*, will carry its pith-ball away from the fixed ball, until the force with which it is repelled is overcome by the twisting or *torsion* of the wire by which *f* is suspended. The number of degrees through which the pith ball *g* is moved, as measured on the scale *a a*, is the measure of the torsion, and therefore of the force of repulsion. Suppose this number to be, as in an actual experiment of Coulumb, the inventor of the torsion balance, 36°. Now, upon turning the nut of the micrometer in the opposite direction to that in which the pith ball moved, let the latter be brought back half the distance (that is, 18°), through which it has been repelled. To effect this, it is found that the micrometer screw must be turned through 126°, which, added to the 18°, gives a total torsion of 144°. To reduce the distance between the two pith balls to 9°—that is, one-fourth the distance through which *g'* was repelled—the micrometer has to be turned through 567°, giving, therefore, in this case a total torsion of 576°.

Employment of the torsion electrometer.

Now let us see what all this means. In the first instance the two balls are 36° apart, and the force of repulsion is exactly balanced at that distance by the force of torsion. Then in the second case the force of torsion is employed to overcome the force of repulsion, *which is of course still acting*, sufficiently to reduce the distance between the balls to 18°—that is, by one half—and the degree of torsion required to do this is 144°. In the third instance the distance between the two balls is reduced to one-fourth the original distance, and the degree of torsion required to effect this is 576°. Now, this evidently shows us that the nearer the two balls approach each other the more powerful is their mutual repulsion, and it remains only for us to see the proportion in which this repulsion varies with the distance.

Explanation of foregoing experiments.

Tabulating the results of the experiment detailed above, we have the following:

Distance.	Force of repulsion.
36°	36
18°	144 = 4 × 36
9°	576 = 16 × 36;

that is to say, if the distance between the two balls be halved, the repulsion is not doubled but quadrupled—while, if the distance be reduced to one-fourth, the repulsion is sixteen times as great. In other words, the force of repulsion (and therefore also of attraction), *varies inversely as the square of the distance.* In this way the application of the law of squares to electrical attraction and repulsion is, by means of Coulomb's torsion balance, satisfactorily proved.

Thompson's quadrant electrometer.

One of the most important and ingenious electrometers is decidedly that of Sir William Thompson—his so-called "Quadrant Electrometer."

In fig. 36 a full view of this instrument is given, while in fig. 37 the instrument is seen dissected.

As will be seen, it consists of four brass quadrants, A, B, C, D, insulated by glass supports, in the same horizontal plane, forming a circular disc with strips cut out across the

diameters. For those who care to make one of these instruments for themselves, we may say that these brass quadrants may be replaced by a ground-glass disc with a hole in the centre, upon which similar quadrants of tin-foil may be passed in such a manner as to leave the diameters of the glass disc bare. Each quadrant is then connected below with the opposite one—that is, A with C and B with D. Two brass knobs, with wires E, F, are attached to two neighbouring quadrants, and form the poles of the instrument.

A needle, G, formed of a thin piece of aluminium, and shaped as shown in the diagram, is suspended above the quadrants by a very thin silver or platinum wire, which is attached to the inside of a small inverted Leyden jar, H. This Leyden jar is supported by a rod, I, and its inner coating is connected with the rod and knob K, while the whole apparatus is covered by a glass shade, the air inside which is kept dry by means of a dish containing sulphuric acid. Finally, upon the wire which suspends G a small mirror is fastened, which will thus of course move with the needle.

The manner in which the instrument is worked is as follows :—A small lamp (not shown in the figure, but any lamp will do), casts a beam of light upon the mirror above G, and this is reflected by the mirror so as to throw a spot of light upon a screen suitably arranged to receive it, and upon which a scale is marked. Of course, as long as the needle remains still the spot of light will do the same, while if the needle move the spot of light will also move along the scale in one direction or the other, according to the nature of the charge which the electrometer receives.

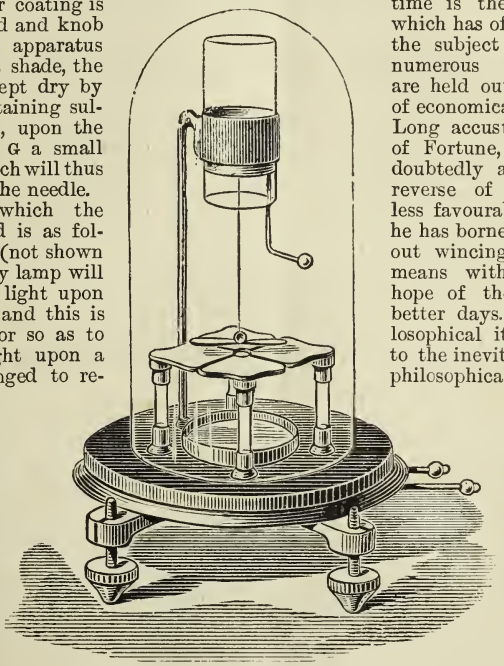


FIG. 36.—QUADRANT ELECTROMETER.

If now one of the knobs, say E, be connected with the earth, the quadrants D and B will be also earth-connected; and if at the same time F receive a charge of positive electricity, the quadrants C and A must share this charge, and they will repel the needle, which will then move in the opposite direction to the hands of a watch, the direction and amount of the movement being registered by the movement of the spot of light upon the screen. If the charge given to F be one of negative electricity, the needle will of course move in the *same* direction as the hands of a watch, and the spot of light will therefore move in the opposite direction along the scale.

This instrument can also be employed with voltaic electricity by connecting E and F with the opposite poles of a voltaic cell.

Here we must leave the important and interesting domain of Frictional Electricity, and in our next paper we shall commence the consideration of the equally interesting and still more important subject of Voltaic Electricity and Magnetism.

HABITS OF THRIFT.

BY THOMAS DUNMAN.

ONE of the most healthy signs of the present time is the great prominence which has of late been given to the subject of thrift, and the numerous inducements which are held out to the cultivation of economical and saving habits. Long accustomed to the smile of Fortune, John Bull has undoubtedly acquired habits the reverse of thrifty, and when less favourable times have come he has borne their pressure without wincing (although by no means without grumbling), in hope of the speedy advent of better days. But however philosophical it may be to submit to the inevitable, it is not at all philosophical to lay upon one's own shoulders unnecessary burdens, nor is it wise to permit the existence of an evil which a little foresight might have prevented. The old habit of charging Providence with sufferings which are but the necessary results of wrong-doing or neglect, has not yet entirely passed away, and people are far too ready to blame their "luck" for what has been brought about by their own folly or misconduct.

That astute philosopher Mr. Micawber lays down the maxim that it is well always to live within your income, "even if you borrow the money to do so." If we leave out the latter portion of this aphorism, the remaining clause contains the whole philosophy of thrift. To be thrifty and economical by no means implies that we are to cut down our expenses to the lowest possible point, or to deny ourselves everything beyond the bare necessaries of life; on the contrary, this would in many cases be a false and not a true economy. The actual expenditure must in every instance depend primarily upon the income, and secondarily upon the actual need—the main thing to be

borne in mind being the necessity of providing not only for present wants but also for future contingencies. Each individual should carefully regulate his expenditure upon this principle; having done which, he has the satisfaction of knowing that whatever balance of income yet remains has no special claim upon it.

Thrifty habits by no means imply mere money-getting or money-saving for the sake only of acquiring wealth. The individual who pinches himself in order to amass wealth, and who is niggardly in all his dealings with others, has nothing in common with the thoroughly thrifty person, who with a keen eye to prevent waste, and a constant watchfulness over unnecessary expenditure, is frequently, and always should be, characterised by generosity and liberality. Those who waste their substance have no opportunity for true liberality, and when they give anything away it is often done in such a manner as to do harm rather than good.

It behoves every one to be especially thrifty with regard to health. It is a popular error to suppose that money cannot purchase health: it often can and does. Many individuals who pride themselves upon their thrifty habits declare that they are never able to afford a holiday, or a little respite from their yearly round of toil. This, however, is the very reverse of thrift; it is reckless prodigality. "All work and no play" not only "makes Jack a dull boy,"—it shortens his life; and to sacrifice health and shorten life in order to obtain a present advantage is the height of extravagance. A little temporary sacrifice would in very many cases prevent the serious injury to health which a too close application to business is sure to cause.

Thrift in matters relating to health is not only shown in taking necessary relaxation from labour, but in exercising due precaution against injuring it in other ways. Many bright careers have been clouded over, many useful lives cut short, through want of attention to the simple rules of health. The young man rejoicing in his strength is peculiarly liable to listen to the siren voice of pleasure, and to step aside from the path of temperance and sobriety, with certain injury to his health as well as the destruction of his peace of mind. But even when such temptations are entirely avoided, young people are very frequently careless of their health, and are apt to think their elders fussy and unnecessarily cautious if they warn them of the risk they run. Nevertheless it is certain that carelessness in this direction is a very dangerous mistake. When the system is robust and the constitution strong, the inroads of disease may be easily prevented by the exercise of ordinary care; but once allow disease to lay hold of the system, and it is far more liable to further attacks than before. We would therefore earnestly advise our younger readers to exercise the utmost thrift in the care of their health, remembering that however superabundant vital energy may at present be, there will come a time when every iota of it will be wanted.

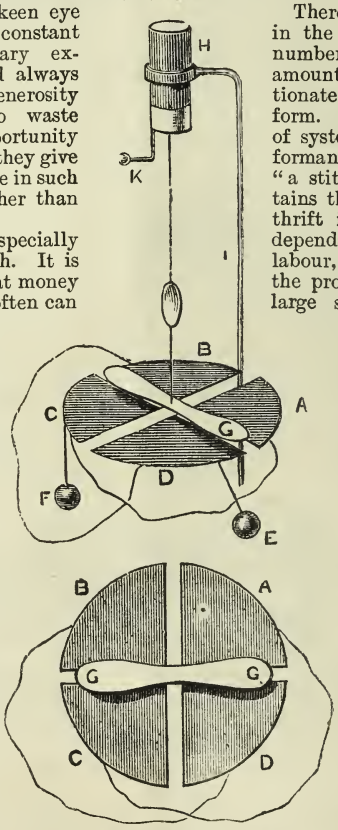


FIG. 37.—QUADRANT ELECTROMETER (*see* p. 288).

There is a great necessity for thrift in the matter of energy. A large number of individuals expend an amount of energy totally disproportionate to the work which they perform. This largely arises from a want of system and regularity in the performance of work. The old proverb "a stitch in time saves nine" contains the entire principle upon which thrift in the employment of energy depends. If every item of daily labour, or of study, be performed at the proper time and in due order, a large saving of needless labour is effected. How often a student, for the lack of just a little more application to the preliminary parts of a subject, entails upon himself a very large amount of work later on! To expend energy wisely it is necessary to give to each task the attention it requires, just when it is required; and if this precaution he neglected, the niggardly or indolent sparing of energy results in a disastrous waste of time and labour which might have been more usefully employed. To be thrifty in the matter of energy it is necessary to proceed deliberately and cautiously, avoiding unnecessary delay, but also guarding against undue haste. Procrastination in every form is an extravagant and unthrifty habit.

A large amount of waste of time might easily be prevented if the habit of thrift were applied to its use. One common source of waste of time is the habit of unpunctuality. Many individuals seem to think that it is unnecessary to keep an appointment, whether for business or pleasure, with scrupulous punctuality. "A few minutes won't make any difference," it is thought or said; and consequently, instead of the meeting taking place at the time appointed, a delay occurs, to make up for which the object of the meeting has to be more hurriedly carried out. The thrifty man is invariably punctual, being too economical to waste his

own time, and too thoughtful to desire to waste that of others.

An economical use of time also implies diligence and industry, combined with perseverance. The busy man is frequently able to devote more time to recreation and amusement than others who have less real work to perform. This arises from the thorough attention which he devotes to his work during business hours; concentrated attention to business or study at proper times leaving the mind entirely free to relax itself during the hours allotted to recreation.

A great obstacle in the way of habits of economy is the fact that it requires some amount of thought, and no little management, to be really thrifty. It is so easy to spend one's time and money without thought beyond that of gratifying the desire or caprice of the moment; and few people seem to think it worth while to "bother" themselves with the expenditure of the thought and consideration which thrift requires. But this surely is an indolent and unworthy excuse. No benefit can be obtained from any course of conduct which does not entail some amount of trouble and self-denial. The right way in which to look at the matter is to carefully count the cost and compare with it the end to be gained. Those possessed of spirit and becoming pride will not for a moment hesitate between the gratification of present desires, with the possibility, and in many cases the certainty, of future suffering and dependence upon others; and the practice of self-denial in the present in order to secure comfort and independence in the future.

The following excellent resolution is said to have been made by one of the most wealthy and enlightened of our merchant princes. It should be adopted by everybody: "To adhere religiously to a determination which I formed at the moment of commencing business, never to incur a debt which I have the remotest apprehension of being unable or even finding it convenient to discharge; and in order to possess the means of keeping this resolution, whatever my income may be, always to live within it." How many easy minded people there would be in the world, were this rule always acted upon.

It is necessary to bear in mind, while cultivating habits of thrift, that these imply not so much saving as wise expenditure. When a definite purpose is to be gained, and especially when useful knowledge is to be acquired, the thrifty person will spend money and time, often with a lavish hand, in the expectation of receiving in the future an increased return of that which has been expended. To expend money in the purchase of useful books, and in the acquirement of knowledge, is to be more truly thrifty than to deny oneself the gratification of the desire for information upon the ground that the money so spent might be saved. At some future time the knowledge thus purchased at a small cost will prove almost invaluable, and a rich return will be reaped for the time and money expended in its acquirement.

It is a great matter also in the matter of saving, to be indifferent to the opinions of other people. "If you live," says Seneca, "according to what nature requires, you will never be poor; if according to the notions of men you will never be rich."

We have said but little about the various ways in which money may be laid by for future contingencies, because so many means of acquiring special information are within the reach of every one. We would advise our readers to possess themselves of this information, so as to make the best possible use of the funds at their command. The Post Office, for example, now offers great inducements to saving, and all should have a thorough acquaintance with the various ways in which money may be deposited with government security, and none are too poor to take advantage of the means now available for laying up a small provision for future necessities. It is foolish and wrong to delay the commencement of habits of thrift on the ground that the amount which can be spared is so small. However trifling the sum saved it will grow larger as time goes on, and the mere fact of having a small sum put by as "a nest egg" is a strong inducement to make every possible addition to the little store.

"Money," says Franklin, "can beget money, and its offspring can beget more, and so on. Five shillings turned is six: turned again it is seven and threepence, and soon till it becomes a hundred pounds."

In conclusion, we would remind our readers that in whatever direction they desire to exercise thrift, it is necessary to distinguish between expenditure which is entirely aimless, and that which may be regarded as a judicious investment. Above all things, beware of taking needless credit. To pay ready money is to reserve to oneself entire liberty to purchase in the cheapest market, and it also keeps one well informed as to the rate at which the funds are being disposed of. When long credit is taken needless luxuries are apt to be ordered without counting fully the cost, and when at last the account comes in, we are surprised to find the total amount to so high a figure.

XXXV.

Mars.—The Minor Planets.

Of all the planets Mars is the one which is the most favourably placed for observation; for, though it does not approach the earth quite so closely as does Venus, yet when it is near the earth it is remarkably well placed for examination, shining in the midnight sky like a miniature full moon, with a brilliancy second to none; whereas Venus, when nearest the earth, turns towards us its unilluminated side.

In figure Mars resembles the earth, being a spheroid departing very little in form from a sphere, its ellipticity being about $1 \div 250$, or

a little greater than in the case of the earth. The polar diameter of the planet is 4215 miles, and its equatorial diameter 4233—these corresponding, when at the same distance as the sun from the earth, to apparent diameters of 9·36″ and 9·40″. When at its furthest distance from the earth the planet resembles in appearance a tiny circular reddish disc scarcely 4″ in diameter, but in opposition it has a mean diameter of nearly 20″. When nearest the earth, as at very favourable oppositions, the real diameter of Mars is as large as 26″. As under these circumstances the planet shines like a brilliant disc against the dark sky, irradiation makes it look still larger, this increase varying from 4″ in small telescopes to 1·5″ in large ones. The mass of the planet is $1 \div 3{,}090{,}000$ that of the sun, or scarcely a ninth of that of the earth; and as its diameter is rather larger than half that of the earth, it follows that its surface is less than three-tenths of that of the earth, its volume less than one-sixth, and its density less than two-thirds, or only about three and a half times that of water. On Mars the force of gravity is only about four-tenths of what it is upon the earth.

Dimensions.

The planet rotates upon an axis inclined at an angle of about 60° to the ecliptic once in 24 hours 37 minutes 22·6 seconds, —this value being tolerably certain, it being deduced from the comparison of numerous drawings made at intervals during over two centuries.

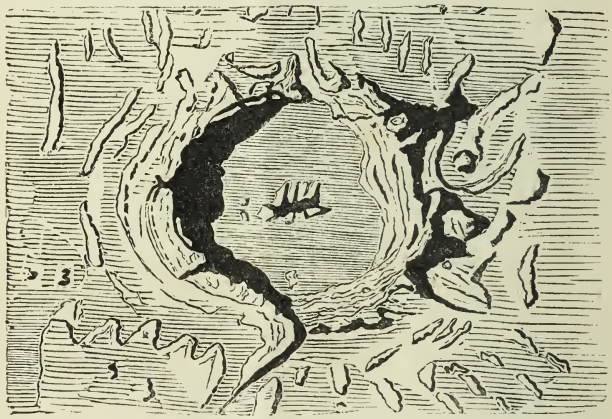


FIG. 88.—THE MOON: THE RING-PLAIN COPERNICUS. (*See* pp. 208 and 226.)

When examined in a telescope, Mars appears like a reddish-yellow disc with a few faint greyish or greenish-grey markings. As the eye becomes experienced in the observation of this planet, these greyish markings become much more easily seen, and a considerable amount of detail can be observed on the disc of the planet, its whole surface being marked out by greyish shadings into an appearance not unlike a terrestrial map. For long it was supposed that these grey spots were only clouds in the atmosphere of the planet, but of late years it has been shown that they are permanent features, and they are with much probability regarded as showing the position of the planetary seas and oceans. If this view be correct, the proportion of land to sea is very different on Mars to what it is on the earth, for whereas on the latter the seas predominate, on the former there is far more land than water. On Mars the waters seem to be distributed in numerous narrow seas and long inlets, which intersect the land in all directions and divide it into numerous islands separated from each other by narrow channels: that is, comparatively narrow, for it is doubtful if any of those which we can see have a less breadth than one hundred miles. Owing to the labours of Proctor, Terby, Burton, and Green, the configuration of the surface of Mars has been carefully mapped, and names have been assigned to the principal dark and light markings, the names being those of the principal observers of the planet.

Telescopic appearance.

Cartography.

A considerable number of other divisions have also received names, such as Kaiser Sea, running north from Dawes Ocean, and Hook Sea, to the south of Herschel Continent.

Some uncertainty, however, yet attaches to the smaller features shown on these maps, as it is only in powerful telescopes that they can be distinctly seen. Another difficulty is introduced by the clouds which from time to time form in the atmosphere of Mars, and cannot be easily distinguished from the yellowish markings constituting the land. These clouds often mask even the larger and more distinct dark seas, and were the origin of the curious changes in the appearance of these darker markings which led to the earlier astronomers taking them for clouds, they forgetting that though clouds seem to us on the earth to be grey, as we see the shadowed or underneath side, on Mars they would seem to us to be white, as we should see the upper illuminated surface.

From a number of observations it is probable that the atmosphere of Mars is but little different in density to that of the terrestrial atmosphere; and the very existence of seas, and of aqueous vapour (revealed by the spectroscope, according to Huggins, Janssen, and Tacchini), shows that the temperature of the planet cannot differ much from that of the earth; for were it less there would be no trace of aqueous vapour to be detected, and were it more this aqueous vapour would be so large in quantity that it would give rise to a permanent screen of clouds, as in the case of Venus. This atmosphere would not extend far from the surface of the planet, but, as in the case of the earth, would form a shallow atmospheric envelope so rapidly decreasing in density that at a height of a hundred miles above the surface it would have become

Atmosphere.

sensibly evanescent. Even when the planet was nearest the earth, the atmosphere would vanish at a distance of 0·4″ from the true limb, or within the limits of the spurious fringe due to irradiation. At the poles of the planet are visible two rounded white spots, which are commonly supposed to be due to the snow and ice accumulated round the poles of the planet, and in support of this view it has been supposed that they wax and wane with the winter and summer seasons on Mars. At times similar isolated brilliant white spots have been seen near these polar caps, and on several occasions even in the equatorial regions of the planet. These white polar caps it has been supposed are not always exactly opposite each other, as they should be if they marked the position of the polar snows, and they are not always circular in form. Some observers have therefore supposed them to be floating masses of ice. It is not improbable that they may be permanent polar strata of clouds, which would vary in shape, position, and form, not only with the seasons, but in a minor manner with the set of the winds and meteorological conditions of the year.

Polar snow spots.

FIG. 89.—THE MOON: SECTION OF RING-PLAIN COPERNICUS SHOWING THE RELATIVE HEIGHT AND BREADTH OF WALLS. (*See* p. 226.)

easily seen with far smaller telescopes, Went-worth Erck having easily seen the outer satellite with a 7½-inch telescope.

These two satellites have been named *Deimos* and *Phobos*, the former being the outer satellite and the one most easily seen, though the latter is probably both slightly larger and a little more brilliant, but being so much nearer to the brilliant planet it is not so easy to see. *Deimos* is distant from the centre of Mars by 32·3″ and its period of revolution is 30 h. 17 m. 53·9 s., and for *Phobos* these quantities are 12·9″ and 7 h. 39 m. 14·0 s., the planet's diameter being taken as 9·4″.

These two moons are the smallest known members of the solar system, with the exception of the meteors—being far smaller than the smallest minor planets. According to the American observers their real diameters are only about six and seven miles respectively; but this is probably much under-estimated, and their real diameters will not unlikely turn out to be about fifteen and twenty miles respectively. The discovery of these bodies opens a new field for research, for if Mars has satellites so small as this, it is not impossible that other of the planets may have similar bodies

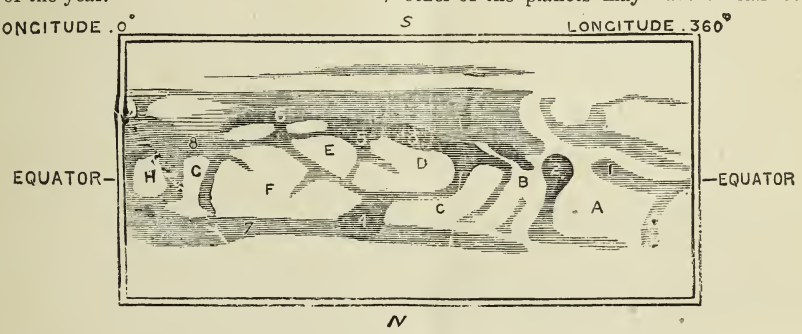


FIG. 90.—CHART OF MARS (Names according to Proctor and Green).

A Beer Continent. B Herschel Continent. C Fontana Land. D Secchi Continent, East. E Secchi Continent, Central. F Secchi Continent, West. G Mädler Continent. H Leverrier Land. 1 Herschel Strait. 2 Dawes Ocean. 3 Maraldi Sea. 4 Oudemans Sea. 5 Trouvelot Bay. 6 Funchal Bay. 7 Campani Sea. 8 De la Rue Ocean.

From this account it will be evident that the condition of the planet Mars is not very different from the condition of the earth, the difference being more in degree than in kind; and it is probable that a persevering study of the features presented by this planet may do much to gain us further real knowledge of the true condition of the other smaller planets of the solar system.

Physical condition.

Until quite lately it was supposed that the planet Mars had no satellite, but in the summer of 1877 astronomers were electrified by the announcement telegraphed from America that Professor Asaph Hall had discovered two small satellites. They were discovered with the magnificent 27-inch telescope at the Washington Observatory; but, as is usually the case, once discovered they were

Satellites.

revolving round them. Even in the case of Venus, such bodies would be very difficult to see even if thirty or forty miles in diameter; and closer scrutiny may yet show one or more satellites revolving round both Venus and Mercury. Similar bodies may also be moving round the larger minor planets—as for instance *Vesta*, *Pallas*, or *Ceres*. Moreover, it is not improbable that yet other satellites to Mars may be discovered when the planet next comes into opposition under exceptionably favourable conditions, as it will in the year 1892.

Existence of other similar bodies.

The Minor Planets.

With the exception of the form and dimensions of their orbits and their motions therein, we know scarcely anything of these bodies except their brightness, which ranges from the

sixth magnitude down to the fourteenth or even below. Even in the largest telescopes they are not to be distinguished in appearance from the ordinary stars of the same brightness, and of their physical conditions we know absolutely nothing. From their brightness we may form some idea of their probable dimensions. The three largest appear to be *Pallas*, *Ceres*, and *Vesta:* their diameter may be taken as about 300 miles; then come *Juno*, *Hebe*, and *Iris*, all about 150 miles in diameter. From these dimensions they gradually descend to very much smaller dimensions, many being under fifty miles in diameter. In number they amount at present to 225, but there can be no doubt that there are at least several hundred not much smaller ones which could be discovered by a systematic search. But so numerous has been the discovery of these bodies of late years that the events have lost all importance and much of the interest which formerly attached to them. So many of them are now known that it has been found impossible to furnish adequate ephemerides for their observation: consequently several have not been observed for years, and one at least has been lost.

Dimensions.

All these bodies move in orbits between Mars and Jupiter, and principally with mean distances lying between the limits 2·10 and 4·00, but mostly near 2·4, 2·7 and 3·0. In the greater number of cases the orbits are neither much inclined to the ecliptic nor very eccentric in form, but there are about twenty which have orbits very much inclined to the others, or else of great eccentricity. Several of the smaller minor planets seem to be associated in pairs, each having orbits of very similar size, form, and position.

XXXVI.

The Arrangement of Words in a Latin Sentence.

Before I give you any lessons on the syntax of government, I think it would be useful, with a view to what follows, to give you a lesson on the arrangement of words in a Latin sentence.

In English prose, and to a very considerable degree in English poetry, as words have not many different endings to determine their grammatical connection, as in Latin and Greek, apart from the order in which they stand, that order is of necessity almost invariable. The Subject or Nominative Case to the verb ordinarily comes first; then the Verb with the Adverb; then after the verb the Object or Accusative or Objective Case; all adjectives occupying a place immediately before the substantives they qualify.

Now, in Latin, far more than in English, the logical position, which follows the *order of thought*, may be altered from two distinct motives—either to give some word *emphasis*, or to give harmony or euphony, as they call it, to the sentence.

But the rules of the arrangement of words in a Latin sentence are so well stated that I give them almost entirely in the words of Arnold, with some improvements and necessary alterations.

The general distinction between the English and Latin order is this:—

I. In Latin the *governed* and *dependent* words generally stand before the words *on which they depend*, so that in simple sentences the verb, when not particularly *emphatic*, stands at the end of a sentence.

II. In simple narratives, after the conjunctions, comes the *subject* (nom. case); then the *governed cases*, with *adverbs* and expressions of *time*, *place*, *manner*, etc., but always observing the order of their relative importance; and last of all the *verb*.

III. If, however, the verb be emphatic, it must be placed earlier in the sentence: *Quod non* DEDIT *fortuna, id non eripit; Mirabile videtur, quod non* RIDEAT *haruspex*, etc.; *Non* INTELLIGUNT *homines quam magnum vectigal sit parsimonia.* For it must always be remembered that—

IV. The degree of *prominence* and *emphasis* to be given to a word is that which mainly determines its position in the sentence.

V. (*a*) The *two most emphatic* positions in a sentence are the *beginning* and the *end:* "by the *former* our attention is *excited*, on the *latter* it *rests*" (Crombie).

(*b*) The more *unusual* the position is for a word, the more emphatic it is *for that word.* Thus—*Arbores serit diligens agricola, quarum adspiciet baccam ipse* NUNQUAM (Cic.).

(*c*) A word generally standing by another *by separation* from it receives emphasis, especially if it be thus brought nearest to the *beginning* or *end* of a sentence VOLUPTATEM *percepi* MAXIMAM; ARDUI EQUITES *ad Cæsarem* OMNES *reverturtur.*

(*d*) Another principle affecting the position of words is the harmonious arrangement of words—the *flow* of the sentence.

VI. *Genitive.*—The genitive, whether dependent upon a *substantive* or *adjective*, stands *first*, if it be *more emphatic;* if not, not. But it is rendered still more emphatic by *separation* (see above, V. *c*).

(*a*) It probably *prefers* somewhat the position before the governing noun, when that is not *decidedly* emphatic.

(*b*) When the governing substantive has an adjective with it, the order is generally *adj., gen., subst.*—VERA ANIMI MAGNITUDO.

VII. *Attributive and its Substantive.*—Of these the more *emphatic* stands *first.*

(*a*) A very short precedes a longer word; hence the *demonstratives* usually stand *before* their nouns, and *monosyllabic substantives before* their adjectives.

(*b*) As a general rule, the *adjective* and *possessive* pronoun *follow* the substantive—as, *Civis* ROMANUS; *Pater* NOSTER; but a *demonstrative* pronoun generally stands *before* the substantive—as, HÆC *mulier;* ILLE *consul.*

VIII. *Apposition.*—Here too the more emphatic precedes; but *generally* the word in *apposition* stands last.

(*a*) This is particularly the case with *titles*, etc., in apposition to *proper names*—as, *Agis* REX; *Pythagoras* PHILOSOPHUS; but URBS *Roma*, yet *Cyprus* INSULA.

IX. *Words dependent on adjectives.*—Here also the more emphatic *precedes*, with something of a *preference* for placing the *dependent* word *last*.

X. *Ablative Absolute.*—The *more emphatic* first.

XI. *Infinitive dependent on Verb.*—The more emphatic *first;* generally the infinitive.

(*a*) Of *two* infinitives the *more emphatic first.*

XII. *Adverbs.*—Usually immediately before the words they belong to. *Quoque* immediately *after* its word.

XIII. Words modifying the meaning of an adjective are usually placed betwixt it and the substantive: *Prælio* MAGIS AD EVENTUM *secundo, quam*, etc.

XIV. *Opposition* and contrasted notions.

(*a*) A *repeated* word, or a word *akin* to a word already used in the sentence, is generally brought as near to that word as possible: TIMOR TIMOREM *pellit; Nulla* VIRTUS VIRTUTI *contraria est;* ALIIS ALIUNDE *est periculum.*

(*b*) Of two contrasted *clauses* or *groups of words*, of parallel construction, the order of the *first* is often *reversed* in the *second*, so that the two *antithetical* words are as *far apart* as possible—FRAGILE CORPUS ANIMUS SEMPITERNUS *movet; Quæ* ME MOVERUNT, MOVISSENT *eadem* TE *profecto.*

Obs.—*Enim, vero, autem, quoque, quidem* (with the *enclitics*), cannot be the first words of a clause.

XV. *Igitur* and *vero* are generally placed after another word at the beginning of the sentence; but if they quite begin the sentence, in this case they are emphatic.

As an illustration of Cicero's perfect style in collocation of words in a sentence, we take the following passage from Cicero pro Milone, 4: "Est enim, judices, non scripta sed nata lex; quam non didicimus, accepimus, legimus, verum ex naturâ ipsâ arripuimus, hausimus, expressimus: ad quam non docti sed facti, non instituti sed imbuti sumus; ut si vita nostra in aliquas insidias, si in vim, si in tela aut latronum aut inimicorum incidisset, omnis honesta ratio esset expediendæ salutis," which we may render thus: "*For this, O judges, is not a written, but an original and inherent law, one which we have neither learnt nor received from tradition, nor read, but which we have taken possession of, derived and elicited from nature herself—a law for which we were made, not taught, to which we were not trained, but accustomed from our youth, that if our life shall have become exposed to any treachery, violence, weapon of robber or personal foe, any means of securing our safety should be honourable.*"

Now, I wish you to observe in the first period of this beautiful and well collocated passage, the principal verb, which is not expressive, yields its position to the words "*expediendæ salutis,*" because they contribute much more to the sense of the passage than does the verb, and are much more forcible, and therefore made more prominent. Observe, too, how the period gains in clearness and emphasis by the use of the rhetorical figure called *anaphora*, consisting in the repetition of *non* and *si;* and how further the fine rhetorical effect is increased by the antithetical arrangement of the verbs *didicimus, accepimus, legimus, arripuimus, hausimus, expressimus*, and of the words contrasted—*scripta, nata, docti, facti, . . . instituti, imbuti.*"

Let us take another illustration from Cicero's sentences, the model of perfect collocation. We quote Cicero pro Murenâ, 2: "Quod si portu solventibus ii, qui jam in portum ex alto invehuntur, præcipere summo studio solent et tempestatum rationem et prædonum et locorum, quod natura fert, ut eis faveamus, qui eadem pericula, quibus nos perfuncti sumus, regredientur, quo tandem me animo esse oportet, prope jam ex magnâ jactatione terram videntem, in hanc, cui video maximas reipublicæ tempestates esse subeundas,"—"*But if those who have left the deep sea, and are now sailing into the harbour, are wont with the most earnest zeal to inform those just leaving it of the character of storms, pirates, and places, because nature prompts us to befriend those who are entering upon the dangers we have passed, with what feelings, I ask, now that I am almost in sight of land, after being terribly tossed about, ought I to regard him, by whom I see the most terrible storms will have to be encountered.*"

Now, on the construction and collocation of these sentences, observe (1) how the subject yields its normal position to the emphatic and important words "*portu solventibus,*" because if it preceded them the clause "*qui jam in portum ex alto invehuntur,*" which qualifies the subject *ii*, and is therefore logically connected with it, would then qualify the object "*solventibus,*" and the sense of the passage would be destroyed. (2) Observe how "*video*" gives place to "*maximas reipublicæ tempestates esse subeundas,*" because it is of much less importance, and because these words require rhetorical emphasis, which is gained by the transposition. (3) Observe how considerable clearness is ensured, and the attention arrested finally, by the direct appeal in the words "*quo tandem animo,*" and the emphatic position of "*in hanc.*"

Questions for Self-Examination.

Why is the order of words in a Latin sentence more variable than in an English sentence? What are the general rules affecting the allocation of Latin words in sentences? What are the two guiding principles of collocation? Give an example of each. What are the rules in the case of apposition, opposition, and of the substantive and the adjective? What are the places of the following in a Latin sentence —*quoque, enim, igitur, vero, meus, hic, autem*, and *ne?* Quote any passage from Cicero, and analyse the clauses with respect to the rules observed in the collocation of the words.

The Syntax of Government.

The Nominative Case.

I. The Nominative case is used to mark the Subject of the sentence—as in *Ego reges ejeci, vos tyrannos introducitis*, I cast out kings, ye are bringing in the despots. Here observe that *ego* in the first sentence, and *vos* in the second sentence, are the nominative cases to their respective verbs, and subjects of their respective sentences.

II. The nominative case is also used to denote the Predicate after the following verbs, which generally mark *existence, naming, appearance: Sum*, I am; *fio*, I become; *audio*, I am called; *appareo*, I appear; *maneo*, I remain; *nascor*, I am born; *exsisto*, I stand forth; *evado*, I turn out; *videor*, I seem; *efficio* and *reddor*, I am made or rendered; *capeor*, I am taken; *creor*, am created; *designor*, am marked out; *legor* and *deligor*, am chosen; *eligor*, am elected; *declaror* and *prodor*, am declared; *renuntior*, am proclaimed; *sufficior*, am supplied; *nominor* and *nuncupor*, am named; *salutor*, am saluted; *appellor, vocor*, am called; *usurpor*, am generally called; *scribor*, am written down; *inscribor*, am entitled; *describor*, am described; *æstimor*, am esteemed; *numeror*, am reckoned; *credor*, am believed; *existimor, putor*, am thought; *ducor*, am deemed; *judicor*, am judged; *habeor*, am held; *censeor*, am counted; *agnoscor*, am acknowledged; *invenior, reperior*, am found; *deprehendor*, am discovered; *arguor, evincor, probor*, am proved; *dicor*, am said; *narror*, am related; *fertor, perhibeor, trador*, am reported.

Observe that some of these verbs, especially the active verbs, are called copulative verbs, as they join together the subject and the predicate; and many of them, especially the passives, as *reddor, creor*—are factitive verbs (from *facere*, to make), because they employ or express the idea of *making*, by deed, thought, or word—as *Nemo nascitur dives*, no one is born rich; *Justitia erga deos religio dicitur*, justice towards the gods is called religion. Observe here that *dives* and *religio* are each of them in the nominative case; the one after *nascitur*, and the other after *dicitur*.

III. The nominative case is used even after the infinitive mood of the above-mentioned (II.) verbs, when they follow *possum, volo, nolo, cupio, incipio, cœpi, desino, videor, existimor*, and the like—as in *Nemo beatus esse sine virtute esse potest*, No one can be supremely blest without virtue. Here *beatus* is the nominative case as the predicate, because it is construed with *esse* after *potest*.

Exercises.

Translate into English :—

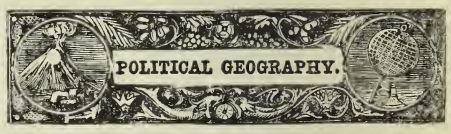
Nemo fit cito turpissimus. Desinant nimium esse timidi. Cato bonus esse quàm videri malebat. Munitiones urbis manebant integræ. In rebus omnibus angustis animosus et fortis appare. Numa Pompilius rex creatus est Romæ. Miltiades non videbatur posse esse privatus civis. Deus est summum bonum. Fides religionis nostræ fundamentum habetur. Natura beatis omnibus esse dedit. Summus magistratus Romanæ civitatis dicitur dictator. Altitudo maris videbatur esse nimia. Ego malo esse doctus quàm videri. Galba creatus est a militibus Romanis imperator Romanus. Amplissimi viri hujusce civitatis facti sunt consules. Orator vehemens desinit esse potens. Boni nolunt esse molesti. Reges nascuntur magni, et invidiæ multæ obnoxii. Catilina et conjurati sui nefarii privati esse nolebant.

Translate into Latin :—

Greece is called the most ancient nurse and mother of philosophy. No one is born a great orator or a great poet. The Romans were esteemed powerful, rich, and brave. Rome was the head of the whole world. Phalaris was esteemed a most cruel tyrant, and guilty of many crimes before God and man. Impious men are the worst of men. Numa was a great worshipper of the gods. Cæsar was said to be the greatest of all Roman generals. Homer is said to have been very fond of wine—a thing which may not be true. Appius Claudius, the dictator, turned out a very bad man and a most cruel tyrant.

Self-Examination Questions.

What is the object of the Latin nominative case in a sentence? Give an example of this. After what verbs, and what kind of verbs, does the predicate take the nominative case? Give examples of this. After what verbs in the infinitive mood is the nominative case used? Form some sentences of these verbs, exemplifying this rule.



II.

GREAT BRITAIN AND IRELAND.

The islands which constitute the United Kingdom of Great Britain and Ireland are situated some distance off the western coast of central Europe, from which they are separated by the North Sea or German Ocean, the Strait of Dover, and the English Channel. They consist of two large islands—Great Britain, and Ireland—and numerous smaller ones arranged singly or in groups around the two principal. The chief of the smaller islands are the Orkney and Shetland groups, the Hebrides, Isle of Man, Island of Anglesea, Scilly Isles, Isle of Wight, and the Channel Islands. They stretch from lat. 49° 13′ to 60° 49′ N., and from long. 1° 45′ E. to 10° 32′ W. In geological formation they correspond with the nearest part of the continent of Europe, indicating that at one time they were connected with it; and the intervening sea is generally shallow. The eastern shores are generally rounded, flat and sandy, while the western or Atlantic coasts are bold, rugged, and much indented. The area is estimated at 122,550 square miles, or about $\frac{1}{30}$ of the entire area of Europe; and the popula-

tion in 1881 amounted to 35,246,633, or more than a tenth of the whole population of Europe.

The climate, though variable, is mild and salubrious, and the mean annual temperature is higher than that of any other country within the same parallels of latitude. The difference between the hottest and coldest months is also much less than in other countries similarly situated. The prevailing winds are from the S.W., and are moist and genial; but in spring cold dry N.E. winds are common. The average annual fall of rain varies greatly in different places; being in some not more than 20 inches, in others—as in some parts of Cumberland—exceeding 100.

The main island of Great Britain lies between lat. 50° and 58° 41′ N. and long. 1° 46′ E. and 5° 41′ W., and has an area of nearly 90,000 square miles, and a population of 29,702,427. It is irregularly triangular in shape, and measures about 600 miles in a straight line from Land's End in the S.W. to Duncanby Head in the N.E., where once stood the famous John O'Groat's House. The highest parts of the country are in the north and west, while towards the east and south the land is generally low, with few elevations of any considerable height. The southern and by much the larger portion of the island is occupied by England and Wales, the northern by Scotland.

ENGLAND AND WALES have the form of a triangular peninsula, bounded on three sides by the sea, and separated from Scotland on the N.W. by a line which extends from the N.E. extremity of the Solway Firth to the mouth of the river Tweed. Its length, measured in a straight line from Berwick in the N.E. to Land's End, is 430 miles, and its greatest breadth about 300. Area 58,320 square miles. Population (1881) 25,968,286. Of these Wales has an area of 7,398 square miles, and a population of 1,359,895.

The coast-line, following the principal indentations, has a length of fully 2,000 miles. The surface of the country is generally level, though it is traversed in different parts by ridges of considerable elevation, chiefly in the north and west. In the centre the land is generally undulating, and in the east are alluvial plains and low marshy ground. The principal mountain chains are the Pennine, Cumbrian, Cambrian, and Devonian ranges. The first of these extends from the Cheviots, on the Scottish border, to near Derby, traversing the counties of Northumberland, Durham, Cumberland, Westmoreland, York, Lancaster, Chester, and Derby. The principal summit is Crossfell, in Cumberland (2,892 ft.). The Cumbrian group occur in Cumberland, Westmoreland, and Lancashire, the principal summit being Scafell (3,161 ft.). The Cambrian mountains, in the west, occupy nearly the whole of Wales; and here Snowdon, the highest mountain of south Britain, rises to 3,570 ft. The Devonian chain stretches through the counties of Devon, Somerset, and Cornwall.

The most important, though not the longest river of England, is the Thames, which falls into the German Ocean after a course of 215 miles. The Severn, which discharges itself into the Bristol Channel, has a course of 240 miles. Next in importance is the Trent, a river of central England, which after a course of 140 miles joins the Ouse to form the Humber. The principal of the other rivers are the Tyne, Wear, Tees, Ouse, Humber, Mersey, Dee, Wye, Medway, and Avon. There are few lakes, and none of them of great extent, the largest being Windermere, which is about ten miles in length by one in breadth.

It is to her mineral wealth, more than anything else, that England is indebted for the high position she now occupies. Her coal mines are the most productive in the world, and yield annually upwards of 116,000,000 tons, of the value of nearly £40,000,000. The coal fields exist chiefly in Northumberland, Durham, Yorkshire, Lancashire, Staffordshire, and South Wales. The most important mineral productions after coal are—iron, copper, lead, tin, zinc, salt, limestone, and various kinds of building stone.

Although wide uncultivated tracts occur here and there, yet few countries have a smaller proportion of land absolutely sterile and incapable of cultivation. The richest parts are in general the midland and southern counties. Towards the north the country partakes of the barrenness of the neighbouring portion of Scotland. The east coast is in many parts sandy and marshy. The principal crops are wheat, barley, oats, rye, beans, peas, potatoes, turnips, carrots, flax, hops, etc.

The manufactures are of great extent and importance, and afford employment to a very large number of the population. The chief of these is the cotton manufacture, which has its principal seat in Lancashire, and which may almost be said to have taken its rise within the last hundred years. The woollen manufacture has existed from a very early period, and is principally carried on in the West Riding of Yorkshire, in and around Leeds, Wakefield, Huddersfield, Halifax, Bradford, and Dewsbury. The manufacture of linen is pursued chiefly in the counties of York, Lancaster, Salop, Durham, and Dorset. The chief seats of the silk manufacture are Spitalfields, Manchester, Macclesfield, and Coventry. The principal of the other manufactures are iron and steel wares (Staffordshire, Shropshire, Birmingham, and Sheffield), leather, earthenware, glass, paper, beer, and spirits. The fisheries constitute an important branch of industry on many parts of the coast.

In proportion to its size, no other country in the world is so well provided with internal means of communication. Besides about fifty navigable rivers, it has 2,300 miles of canals, 12,500 miles of railway, 3000 miles of tramways, 24,000 miles of turnpike roads and paved streets, and about 100,000 miles of cross-roads.

England is divided into forty and Wales into twelve shires or counties, most of which are subdivided into hundreds and all into parishes, which are both ecclesiastical and civil divisions.

Yorkshire is divided into three parts called Ridings, which are subdivided into wapentakes. The principal towns, with their populations in 1881, are — London, 3,814,571; Liverpool, 552,425; Manchester and Salford 517,741; Birmingham, 400,757; Leeds, 309,126.

The established religion is the Protestant Episcopal, but the most complete toleration is extended to all other religious sects. There are two archbishops and twenty-nine bishops. The number of benefices is about 13,500, and of clergy of every class about 23,000. The number of adherents is estimated at over 13,000,000, and the revenues from every source are probably little short of £8,000,000 annually. The principal of the other sects are Methodists, Independents, Baptists, Roman Catholics, Presbyterians, and Unitarians. The average school attendance is 2,595,000.

England was known to the Phœnicians, who resorted hither for tin, at least four centuries before the Christian era. The aboriginal inhabitants were Celts, who inhabited the country when it was invaded by Cæsar, B.C. 55. It was abandoned by the Romans early in the fifth century, and subsequently was overrun by the Anglo-Saxons, the Celtic inhabitants being driven into the remote and mountainous regions of Wales and Cornwall. The Saxons formed seven kingdoms called the Heptarchy, each of which had its separate chief, till they all became united under one head. The country was subsequently invaded by the Danes; and finally came under the power of the Normans, after the battle of Hastings, in 1066. Thus the population of England is a mixed Celtic, German, and Norman one, and characteristics of each are to be found combined in the national character.

SCOTLAND comprises the northern and smaller portion of Great Britain, and measures in length from north to south 275 miles, with breadth varying from 30 to 175 miles. Area 30,460 square miles. Population (1881) 3,734,441.

The surface of the country, as compared with England, is generally speaking rugged and mountainous, and even where least mountainous is commonly varied with hill and dale. With the exception of a few rich alluvial tracts, there are no extensive plains. The principal mountain chain is that of the Grampians, which extends from N.E. to S.W. across the country. It contains the loftiest summits in Britain, the highest being Ben Nevis (4,406) and Ben Macdhui (4,296). South of the Grampians and running parallel to them is the range of the Sidlaw, Ochil, and Campsie hills. South of these, and separated from them by the Forth basin, are the Lammermuir and Pentland hills; while on the border, and situated partly in England and partly in Scotland, are the Cheviots.

The principal rivers are the Tweed, valuable for its fisheries; the Forth, which has a very winding course, and is navigable to Sterling; the Tay, which is navigable to Perth, and said to discharge a greater quantity of water than any other in Britain; the rapid Dee and Spey, from the Grampians; and the Clyde, commercially the most important river in Scotland, and navigable to Glasgow. The lakes are numerous, the principal being Loch Lomond (the largest in Britain, twenty-four miles in length), Loch Awe, Loch Tay, Loch Rannoch, Loch Ericht, Loch Ness. The coast is much broken by arms of the sea, so that the coast-line is not less than 2,500 miles in length.

The most important mineral productions are coal and iron. The great coal-fields extend through the middle of the country from the eastern to the western coast, on both sides of the rivers Forth and Clyde. Annual produce about 18,000,000 tons. Iron is largely found in the coal districts, especially in Lanarkshire. In addition to these, lead, copper, silver, gold, antimony, cobalt, manganese, etc., are found. Slate, limestone, sandstone, and granite are common.

Agriculture has here attained a high state of perfection, and in some parts is not surpassed in any other country. The principal crops are wheat, oats, barley, beans, peas, potatoes, turnips, etc. The manufactures are similar to those of England. The chief seats of the cotton manufacture are Glasgow and Paisley. The woollen manufacture is carried on in Galashiels, Hawick, Paisley, Kilmarnock, and Aberdeen. The linen manufacture has its chief seat in Dundee, but is also largely carried on in Forfar, Arbroath, Montrose, and Aberdeen. The fisheries on the coast are extensive and valuable. There are 2,900 miles of railway in operation, and 3,800 miles of turnpike roads, besides navigable rivers and canals. The principal towns, with their populations in 1881, are Edinburgh, 228,190; Glasgow, 511,532; Dundee, 142,454; Aberdeen, 105,054.

The established religion is Presbyterian, governed by kirk sessions, presbyteries, synods, and a general assembly held annually in Edinburgh. Probably about one-half of the population belong to the Established Church. The most powerful of the dissenting bodies is the Free Church, which separated itself from the Establishment in 1843. Then follow the United Presbyterians, and after them Independents, Episcopalians, Roman Catholics, etc. Education is widely diffused among all classes, and the average school attendance is 385,000.

Scotland was originally independent, and governed by her own kings till the accession of James VI. to the English throne in 1603, when the whole of Britain came under the dominion of one sovereign. The complete union of the two countries was effected in 1707.

IRELAND lies west of Britain, from which it is separated by St. George's Channel, the Irish Sea, and the North Channel, and on the north, west, and south is washed by the Atlantic. It is rhomboidal in shape, and is 225 miles in length from north to south, by 174 in greatest breadth. Area 32,524 square miles. Population (1881) 5,159,839.

The north, west, and south coasts are indented with numerous deep and safe bays, and the islands are numerous but small in size. The

greater part of the surface is flat, interspersed here and there with low hills. There are few mountains, but some of them attain a considerable elevation. The principal are the Mourne mountains, in Down county; the mountains surrounding Clew Bay, in Mayo county; Macgillicuddy's Reeks, in Kerry county (of which Carran Tual is the highest point in Ireland, being 3,414 feet); and the Wicklow mountains. The rivers are numerous, the principal being the Shannon, 254 miles long, and navigable for nearly the whole of its course. Among the others are the Suir, Barrow, Nore, Blackwater, Slaney, Boyne, Foyle, Erne, Lee, Bandon, Bann, and Moy. The lakes or loughs are numerous, the largest being Loughs Neagh, Erne, Corrib, and Mask. The lakes of Killarney are noted for their scenery.

The climate is mild and temperate, but moist, and more suited for pasture than agriculture. Hence the brilliancy of its verdure, which has gained for it the name of the "Emerald Isle." The soil in general is of great fertility, but from lack of energy and bad management it is not turned to the best account. The majority of the holdings are small. The principal crops are wheat, oats, barley, rye, beans, peas, potatoes, turnips, carrots, and flax. About one-seventh of the total area of the island is occupied by turf or peat bogs. The country is rich in minerals, but they are not taken advantage of as they might be. Coal and iron are widely distributed, but of the former only about 130,000 tons are raised annually. The other minerals are copper, lead, silver, gold, zinc, antimony, tin. salt, sulphur, etc. The manufactures are chiefly woollen, linen, and cotton stuffs, silk, sewed muslins, paper, spirits. The surrounding seas abound with fish. Length of railways 2,290 miles.

Ireland is divided into four provinces—Ulster, Leinster, Connaught, and Munster; and these are subdivided into thirty-two counties. The chief towns are Dublin (which has a population of 338,579), Belfast, and Cork. About four-fifths of the population are Roman Catholics, under the superintendence of four archbishops and twenty-six bishops. Only about one-tenth of the people belong to the Protestant Episcopal Church, which previous to 1871, when it was disestablished, was the established religion of the country. The Presbyterians number about 485,000 adherents.

Ireland was conquered by England in the twelfth century, but remained a distinct kingdom till 1801, when it was joined with England and Scotland to form the United Kingdom of Great Britain and Ireland. The executive government is vested in a lord-lieutenant, who must be a peer, assisted by a privy council appointed by the crown, and by a chief secretary, a member of the house of commons.

THE UNITED KINGDOM.—The form of government is a limited monarchy, consisting of the sovereign and the two houses of parliament, lords and commons, without whose joint approval no legislative measure is complete. The executive power is nominally vested in the sovereign, who summons and dissolves parliament; but on the principle that "the king can do no wrong," the ministers of the crown are responsible for the acts of the sovereign. The house of lords at present consists of six princes of the blood royal, two archbishops and twenty-four bishops, 426 English peers, sixteen Scotch and twenty-eight Irish representative peers,—in all 502 members. The house of commons is composed of 658 members, being 493 for England and Wales, 60 for Scotland, and 105 for Ireland. In 1881 the public revenue amounted to £84,041,288, the gross expenditure to £83,107,924; while the national debt was £768,703,692. The regular army numbered 188,958 men; the volunteers, 206,537; militia, 137,971; and the navy, 79,250 men, boys, and marines.

The total number of vessels registered at the different ports are:—Sailing vessels 32,622, tonnage 5,729,095; steam vessels 6,629, tonnage 2,733,269. The total number of vessels that entered the different ports in 1879 was 351,238, tonnage 65,706,633; that cleared, 314,351, tonnage 60,705,578. The total imports amounted to £362,991,875, of which wheat and other kinds of grain £52,000,000; raw cotton £36,000,000; silk manufactures £12,000,000; wood and timber £10,000,000; sugar £22,000,000; wool £23,000,000; tea £11,000,000; butter £10,000,000; beef, bacon, and hams £10,000,000; living animals, oxen, sheep, etc., £7,000,000. The total exports were:—£248,783,364, of which £182,274,391 were produce and manufactures of the United Kingdom. The chief items were cotton yarn and cotton manufactures £60,000,000; iron and steel wares £19,000,000; woollen and worsted goods £15,000,000; coal £7,000,000; linen manufactures £5,000,000. In 1880 the total imports were £411,230,000, the exports £286,414,000. The imports are chiefly from the United States of America, France, British India, Australia. Germany, Holland, Russia, China, and Belgium; the exports chiefly to Germany, France, the United States of America, British India, Australia, Holland, Belgium, and Russia.

Great Britain, with its numerous dependencies, has an area of 8,982,000 square miles, and a population of 303,000,000.

A map of Great Britain and Ireland will be found on p. 330.

XXXVI.

THE REIGN OF JAMES I. (*concluded*).—CHARLES I.

IN the period succeeding the death of the lord treasurer, Cecil, in 1611—the year in which James also lost his eldest son Henry, Prince of Wales—the government went from bad to worse. The common law of the land was continually set aside and overridden

Misgovernment and corruption.

by high-handed decrees of the Court of High Commission and the Star Chamber. Monopolies, a great and standing grievance, were increased, until the names of such men as Sir Giles Mompesson (the original of Massinger's Sir Giles Overreach in the "New Way to pay Old Debts") became hateful to the nation. An aged clergyman, Peachum, was cruelly tortured by means of the rack, and was left to die in prison, for having written a sermon against the king's misrule. The Puritans were greatly mortified and incensed at a proclamation published in 1618, allowing public sports on Sundays, after divine service; and the temper of the powerful sect was shown in the emigration of the Pilgrim Fathers, who, in 1620, preferred to quit their country and seek new homes beyond the western main, rather than submit to the harsh rule imposed on them in their native land.

But the part of the king's policy which aroused the greatest indignation in England was the approximation of James towards Spain, a country held in detestation from the time of Mary and Philip II., downwards.

Attempt to conciliate Spain.

The king now endeavoured to conciliate the Spanish government by various expedients, the meanest of which was the execution of Sir Walter Raleigh on the sentence pronounced in the Main plot fifteen years before. Ostensibly the execution was in consequence of Raleigh's failure in Guiana; in reality the whole nation saw in it an unkingly endeavour to give satisfaction to Spain.

CHARLES I.

At length, in 1621, a parliament met; and in no friendly humour. The king had given great offence by his Spanish policy, by which he hoped to exhibit a triumph of kingcraft. Since 1618 the Thirty Years' War had been raging on the Continent. The Count Palatine Frederick, the "winter king of Bohemia," was the husband of James's daughter Elizabeth. That unhappy prince had been deprived of his palatinate, and was now a fugitive. Deceived by Spanish cunning, King James had expected to gain by diplomacy a favourable settlement of his son-in-law's claims, and was grievously duped. The parliament was determined, moreover, to obtain the redress of grievances. Mompesson and Mitchell were punished by fine and imprisonment. The great chancellor, Francis Bacon, impeached for bribery, made an abject submission, and thereby probably saved himself from total ruin. The bias of the parliament towards upholding the cause of the Protestants on the Continent, was further seen in the outrageously severe sentence of a £5,000 fine, with whipping, pillorying, and perpetual imprisonment, passed upon a Roman Catholic gentleman named Hoyd, a captive in the Fleet prison, for expressing his joy at the expulsion of "goodman Palsgrave" and "goodwife Palsgrave" from Prague. In the next session the commons took upon themselves boldly to point out to the king the inconveniences and injuries that would arise from the marriage of the Prince of Wales to a Roman Catholic princess; for upon a Spanish marriage the king had set his heart. They also drew attention to the increase of popery in the country; for James had greatly abated the rigour of the laws against the Roman Catholics. The angry admonitions of the king to the house, exhorting the members not to meddle with state mysteries, produced the celebrated Protestation, in which the commons utterly repudiated the king's assertion that their privileges depended only on the grace and favour of the monarch; declaring that the liberties, franchises, and jurisdictions of parliament are the ancient and undoubted birthright and inheritance of the subjects of England. They especially vindicated the right of freedom of speech and of remonstrance, and the immunity of members against arrest. Highly incensed at this display of spirit, James sent for the journals on which the protestations had been entered, tore out the leaves that contained the obnoxious declarations, and soon after dissolved the parliament, committing several of the leading members to prison.

Mompesson and Mitchell.

Parliamentary Protest of 1619.

The intended Spanish match, however, resulted in a Spanish war. By a judicious display of reluctance, the Spanish court had obtained from the king great and important concessions, including a promise not only to suspend the execution of the penal laws against the Romanists, but to procure their abrogation by the parliament. But then came the project of "Steenie" to carry off "Baby Charles" to Madrid, to claim the bride, as James in his younger days had taken away his queen, Anne, from Denmark. Then followed the complications at the Spanish court; the quarrel of the haughty English favourite with the Count de Olivarez, at that time all-powerful at Madrid. Buckingham, seeing his own power and popularity at stake if the marriage took place, lent his efforts to break off the match, and succeeded; the whole blame being thrown on the Spanish court before the next parliament, both by the duke and the prince. Then, to the great joy of the people, war was declared against Spain; and shortly before his death the weak king prepared to take an active part in the regaining of the palatinate, a purpose for which the commons granted £300,000. At the same time an act was passed declaring all monopolies illegal; and thus a great point of difference was definitely settled to the advantage of the nation.

War with Spain.

The king had not learnt to appreciate the depth of the people's aversion to a Roman Catholic match for the heir to the throne; and immediately after the failure of the Spanish marriage he was engaged in negotiating a French alliance for Prince Charles. He sought and gained for him the hand of the Princess Henrietta Maria, the youngest daughter of Henry IV.; and Richelieu obtained from the weak king various concessions that could not fail to make the marriage unpopular in England—such as the stipulation that the queen was to have the charge of educating the children till they were twelve years old; and various vague promises of suspension of penal laws against the Romanists were also made by James.

Marriage of Prince Charles with Henrietta Maria.

The ignoble reign of the first Stuart king of England came to an end by James's death, on the 27th of March, 1625. The twenty-two years of his rule mark the first epoch of the struggle between the prerogative of the king and the freedom of the subject.

The Reign of Charles I.—Periods I. and II.

The reign of Charles I. is memorable as the period at which the great question of the prerogative of the king against the rights of the people—absolute government as against freedom—was brought to the stern decision of war. James I., though sufficiently inclined to oppress his subjects, was too timid a man to be a dangerous enemy to the liberties of England; retiring before the spirit of his time, as a great historian describes it, scolding and protesting as he went. But Charles was a king of a different type. The system of despotic government he had planned he was determined to carry out to the uttermost; and thus, from the 27th of March, 1625, the day on which he succeeded to the crown, the struggle for the liberties of the people of England began in earnest.

Royal prerogative and popular rights.

STRAFFORD.

The reign of Charles may be divided into three periods. They are of unequal length, but mark the great changes in the government. The first is from 1625 to 1629, and comprises the time of the king's strife with three successive parliaments. The second extends from 1629 to 1640, and extends throughout those eleven shameful years when the king ruled without a parliament, and the royal will, backed by arbitrary decisions of the Star Chamber and the Court of High Commission, was substituted for the ordinary law of the land. The third and closing period, from 1640 to 1649, begins with the enforced return of the king to parliamentary government, upon the lamentable failure of his own system, and ends with that mournful 30th of January, 1649, when the grey discrowned head, still surrounded in the eyes of many with "the divinity that doth hedge a king," fell beneath the axe of the masked executioner, on the scaffold at Whitehall.

Three periods: 1629-1640-1649.

Soon after the king's accession the parliament met, and in no complying mood. The Spanish war was a reason for Charles's urgent demand for money; but the commons, among whom were Wentworth, Pym, Sandys, Sir John Eliot, and other leaders of the popular party, were determined to make supply contingent upon the redress of grievances. They had also ascertained that ships fitted out against the Genoese had been sent against the Huguenots at Rochelle, then fighting for their religion against Richelieu. A scanty supply of two subsidies, about £140,000, was soon followed by the dissolution of this first parliament of his reign by Charles, on the 25th of August, after a session of only a few weeks. To raise money the king now resorted to the device of forced loans;—the old expedient of *benevolences*, an exceptional resource of former kings, not warranted by law, being revived by him. A fleet sent against Cadiz, under Lord Wimbledon, failed ignominiously; and Charles, in great want of money to prosecute the war, summoned his second parliament, in February, 1626. The commons immediately proceeded to impeach Buckingham, the king's worthless favourite, whom they accused of extortion and tyranny, of misleading the king, and of having provoked the Spanish war. In high indignation at this assertion of power, the king dissolved the second parliament; and Sir John Eliot and Sir Dudley Digges, who had been foremost in the proceeding, were committed to the Tower.

First and second parliaments.

Forced loans and benevolences.

Second parliament dismissed.

This second parliament had read for the first time a bill granting a supply of money to the king, but had been dissolved by Charles before the bill could become law: the king nevertheless collected the money by the strength of his proclamation alone, though great discontent was excited, and the cry "No parliament, no subsidies," in many riotous meetings, gave evidence of a dangerous state of the public mind.

The king's evil genius, Buckingham, now involved him in a quarrel with Richelieu, and a war with France was the result. Buckingham took command of an expedition for the relief of the Huguenots of Rochelle, then besieged by Richelieu. His complete mismanagement having produced utter failure, he returned to England, to be put in command of another force for La Rochelle by his infatuated master. But he was destined to

War with France. Buckingham's expedition.

make no more blunders; for at Portsmouth, as he was preparing to embark, he fell beneath the dagger of Felton, a moody discharged officer, to whom he had given offence.

Meanwhile the later supply, obtained by a general forced loan—paid with a very bad grace by a discontented nation, among whom many individuals suffered imprisonment rather than contribute their share—had been completely exhausted, and a fresh sum was imperatively needed. Accordingly, in March, 1628, a third parliament was called. The new house of commons included many men of wealth and influence, sternly determined to oppose the despotic proceedings of the king, and to uphold the liberty of the English nation. There had been many acts of arbitrary power which had excited disquietude and anxiety: besides the collection of unauthorised taxes, the billeting of soldiers in private houses had been a grave source of complaint. Martial law was applied to the punishment of ordinary offences. Members of parliament and others who had freely expressed their opinions as to the illegality of forced loans, and of other proceedings of the government, had been committed to prison.

Third parliament.

Such were the very sufficient reasons that induced the parliament to draw up and present to the king that famous Petition of Right, which has with justice been termed the second Magna Charta. The king, in consideration of five subsidies voted to him, gave his assent to this document, and thus bound himself to abstain from levying taxes without the consent of parliament, from billeting soldiers in private houses, from trying citizens by martial law, and from imprisoning any man, except in due course of law.

The Petition of Right.

XXXVI.

Double Rule of Three.

In questions in the Rule of Three we are given three things from which to find a fourth. Similar questions may be set in which we are given five things to find a sixth, or seven things to find an eighth, and so on. Each question can be solved by a method analogous to the Rule of Three, called Double or Compound Rule of Three.

In these cases, as in Simple Rule of Three, the required quantity and one of the given quantities must form a pair of quantities of the same kind, while the remaining given quantities must fall into pairs of other kinds. Also, as in the Rule of Three, the kind of quantity which forms any of the latter pair must be proportional, directly or inversely, to the quantity of the former kind.

Example.—If 18 men, working 8 hours a day, earn £20 a week, how much a week will 150 men earn, working 6 hours a day?

Here the required thing is earnings, which is the same kind of thing as the £20; the 18 men and the 150 men form a pair of things of one kind, and the 8 hours and 6 hours are a pair of things of another kind. Also the amount of earnings is directly proportional to the number of men, and it is also directly proportional to the number of hours of work—*i.e.*, the earnings will increase in proportion to the number of men if the number of hours remain the same, and in proportion to the number of hours of work if the number of men remains the same.

This and all similar examples may be solved by two or more Rule of Three statements, which are eventually *compounded* into one simple statement (hence the name *Compound* Rule of Three).

First we may ask—Supposing the number of hours to remain the same in both cases, how much would 150 men earn when 18 men earn £20? Clearly the answer to this question is given by the Rule of Three statement

$$18 : 150 :: 20 : \text{required sum},$$

which gives the required sum $= £20 \times \frac{150}{18}$—*i.e.*, 150 men, working 8 hours a day, would earn this much. But we require to know how much 150 men would earn working 6, not 8, hours. Clearly the answer to this is given by the statement

$$8 : 6 :: £20 \times \tfrac{150}{18} : \text{required sum},$$

$$\therefore \text{required sum is} = £20 \times \tfrac{150}{18} \times \tfrac{6}{8}.$$

Now, this is the answer we should get if we had taken the two statements

$$18 : 150 :: 20 \ldots\ldots (1),$$

$$\text{and } 8 : 6 :: 20 \ldots\ldots (2),$$

and had made a single statement out of the two, by taking the common 3rd term for a new 3rd term, the product of the two 2nd terms for a new 2nd term, and the product of the two 1st terms for a new 1st term.

Thus $18 \times 8 : 150 \times 6 :: 20 :$ required sum, from which, as before, required sum $= £20 \times 150 \times 6 \div 18 \times 8$.

The two statements may be written thus—

$$\left.\begin{matrix} 18 : 150 \\ 8 : 6 \end{matrix}\right\} :: 20$$

We see, therefore, that such a question as this really consists of two Rule of Three questions. Statement (1) is made on the supposition that the number of hours is the same for both sets of men; and statement (2) is made on the supposition that the number of men remains the same while the number of hours of work is different.

We can now understand the following rule:—

Arrange the quantities corresponding to the two suppositions in two lines, placing quantities of the same kind under one another, thus—

men.	hours.	£
18	8	20
150	6	

Make the required quantity the 4th term of a statement, and the given quantity of the same kind the 3rd term. Take the first pair of quantities of the same kind, and having reduced

them to the same denomination, arrange them and the 3rd term as in a Rule of Three statement, supposing the numbers in the other pair to be equal to each other. Then take the second pair, and treat them in a similar manner; and if there are other pairs, pursue the same course with them. Finally, multiply the common 3rd term by the product of all the 2nd terms, and divide by the product of all the 1st terms. The result is the required quantity.

Example.—If 120 men build a wall 60 feet long in 15 days, how many men will be required to build a wall 110 ft. long in 20 days?

We arrange thus:—

60 ft. 15 days 120 men
110 „ 20 „ ?

The statement will therefore be

60 : 110 } ::120 · required number of men.
20 : 15 }

For, supposing the number of days to be the same, we ask how many men would be required to build 110 ft. when 120 are required to build 60 ft.?

Clearly 60 : 110 :: 120.

Again, supposing the number of feet to be built to be the same, how many men would be required to do the work in 20 days if 120 men can do it in 15 days?

Clearly 20 : 15 :: 120.

The final statement will therefore be the above, viz.:—

60 : 110 } ::120 : required number of men.
20 : 15 }

$$\text{Ans.} = \frac{110 \times 15 \times 120}{60 \times 20} = 165.$$

Example.—If a ship carrying 1000 souls has rations sufficient for a journey of 30 days at the rate of 22 oz. a day for each person, how many oz. a day can be spared if the number of souls on board be increased to 1250 just as the ship is starting, and the journey is expected to take 3 days longer?

Arrange thus:—

1000 men 30 days 22 oz. rations
1250 „ 33 „ ?

To make the provisions last 30 days the rations are 22 oz., ∴ to make the provisions last 33 days the rations must be less than 22 oz.; ∴ 33 : 3 :: 22.

Also, as the provisions just suffice for 1000 men when rations are 22 oz., the rations must be reduced so as to suffice for 1250 men for the same time. Hence

33 : 30 } :: 22 oz.
1250 : 1000 }

$$\text{Ans.} = \frac{22 \times 30 \times 1000}{33 \times 1250} = 16 \text{ oz.}$$

Example.—If 32 cannon, firing 2 rounds in 6 minutes, kill 500 men in 3 hours, how many cannon, firing 3 rounds in 5 minutes, will be required to kill 400 men in 4 hours?

Arrange thus:—

2 rounds 6 min. 500 men 3 hrs. 32 cannon
3 „ 5 „ 400 „ 4 „ ?

Supposing everything else to remain the same, then the greater the number of rounds the fewer cannon are required; ∴ 3 : 2 :: 32.

Again, the greater the interval between the rounds the more cannon will be required; therefore the next statement will be 5 : 6 :: 32.

Again, the more men are to be killed the more cannon, it will be observed, will be required; ∴ 400 : 500 : : 32.

Lastly, the greater the number of hours the fewer the cannon; ∴ 4 : 3 : : 32.

Hence finally—

3 : 2 }
5 : 6 } : : 32 : number of cannon required.
400 : 500 }
4 : 3 }

$$\therefore \text{ No. of cannon required} = \frac{32 \times 2 \times 6 \times 500 \times 3}{3 \times 5 \times 400 \times 4} = 24. \quad \text{Ans.}$$

We come now to speak of the interesting subject of—

Per-Centage.

"Cent." is an abbreviation of the Latin word *centum*, a hundred, and "per cent." means "for a hundred." Thus 3 per cent. means 3 for 100 : 3 in this case is called the *rate* per cent.

The *per centage* is the amount which a given *rate* per cent. produces from a given number. Thus, at the rate of 3 per cent., the per centage on £100 is £3, the per centage on £200 is £6, on £250 is £7 10*s.*, and so on.

Questions in Per Centage are particular examples of the Rule of Three, and are solved by the principles of Proportion. Whenever it is necessary—as for commercial and practical purposes it often is—to compare the ratios which different pairs of numbers give rise to, it is necessary to reduce the ratios to equivalent ratios having a common antecedent or a common consequent (the latter being the better)—*i.e.*, to reduce the fractions which express these ratios to equivalent fractions having a common denominator. The most convenient denominator is some power of 10, and the one usually adopted is 100.

Profit and loss, increase and decrease of population, and so on, are generally calculated with reference to 100 as a standard. For instance—

A town whose population 2 years ago was 12000 has now 12360, while another town has increased from 28000 to 28980. Which has increased most in proportion to the population?

The absolute increase of 1st town is 360,

∴ its rate of increase in proportion to its population is $\frac{360}{12000}$.

In the same way, the rate of increase of 2nd town in proportion to its population is $\frac{980}{28000}$.

It is not evident which of these two is the greater; but by two Rule of Three statements we can find two numbers which shall bear the same ratios to 100 that these antecedents bear to their consequents.

Thus we find $\frac{360}{12000} = \frac{3}{100} = 3$ per cent.,

and $\frac{980}{28000} = \frac{3\frac{1}{2}}{100} = 3\frac{1}{2}$ per cent.;

i.e., the first town has increased at the rate of 3 for every 100, and the second at the rate of $3\frac{1}{2}$ for every 100.

There are two or three classes of questions

in Per Centage which occur frequently, of which we shall now give some examples.

I. To find how much per cent. one given quantity is of another.

(1) How much per cent. of 120 is 90?—*i.e.*, what number has the same ratio to 100 that 90 has to 120?

Clearly 120 : 100 : : 90 : required number;

$$\therefore \text{ required number} = \frac{100 \times 90}{120} = 75.$$

(2) In a battle 325 persons are killed on one side out of an army of 15000, and on the other side 1120 are killed out of 17000. What per centage of the whole number of troops fell?

Total number of troops engaged = 32000
Total loss = 1445

∴ 32000 : 1445 : : 100 : required number;
∴ Required number = $4\frac{1}{2}$ nearly.
Ans. $4\frac{1}{2}$ per cent. (approximately) fell.

II. To find how much a given per centage of a given quantity amounts to.

(1) Find the value of 3 per cent. of £1820.

3 per cent. of £1820 means £3 for every £100 in £1820,

which is = $\frac{3}{100}$ of £1820 = £54 12*s.*

(2) In a certain mixture of tea 25 per cent. is China tea and the rest Indian. How much of the latter is there in 1375 tons of the mixture?

$\frac{75}{100}$ of each ton is Indian, ∴ in 1375 tons of mixture there are $\frac{75}{100} \times 1375$ tons of Indian = 1031·25 tons = 1031 tons 5 cwt.

III. The per centage on a quantity and the rate per cent. being given, to find the quantity.

The rate per cent. is to the per centage as 100 to the required quantity,

i.e., rate per cent. : given per centage : : 100 : required quantity;

$$\therefore \text{required quantity} = \frac{\text{given per centage} \times 100}{\text{rate}}$$

Example (1) :—

A man's capital is invested at $3\frac{1}{2}$ per cent. What must be the amount of his capital when his income from it is £1428 per annum?

Clearly what he gets from £100 is to what he gets from his whole capital as £100 is to his capital;

i.e., $3\frac{1}{2}$: 1428 : : £100 : capital;

$$\therefore \text{capital} = \frac{1428 \times 100}{3\frac{1}{2}} = £40800.$$

Example (2) :—

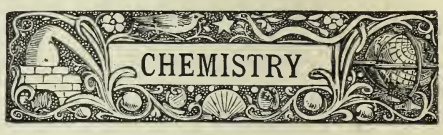
The per centage on the tobacco passing through a certain custom-house amounts to £725 6*s.* 8*d.* in the year, the duty being 15 per cent. Find the value of the tobacco passing through the custom-house in a year.

15 : £725 6*s.* 8*d.* : : 100 : required value;

$$\therefore \text{req. value is} = \frac{725\frac{1}{3} \times 100}{15} = £4835\ 11s.\ 1\tfrac{1}{3}d.$$

Commission and *Brokerage* are charges made by agents who buy and sell goods or stock for other persons. These charges are generally so much per cent. on the value of what is bought or sold, and therefore questions concerning them are really questions in Per Centage.

Insurance is an agreement by which one party is bound to pay another a specified sum of money on the happening of a certain event. The person who is bound to pay is called the insurer; the other person, to whom the money is to be paid, is called the insured. The consideration given by the insured for this agreement is generally the annual payment of a per centage on the amount insured. This consideration is called the *premium*, and the instrument which expresses the contract is called the *policy*.



XXXIV.

Spectrum Analysis (*continued*).

We have already spoken of the rainbow as an example of refraction or bending of the light rays out of the straight course, and must now proceed to say a few words concerning the nature of this phenomenon. Our readers have doubtless observed the brilliant prismatic colours exhibited by dewdrops or the cut-glass pendants of a chandelier under the influence of light. The fact is that the ray of light is what is familiarly termed decomposed, or broken up into its constituent elements of colour, in passing through these transparent substances. In other words, they act as prisms, and bending the ray of light out of the straight line, transmit its undulations in directions whose angle varies somewhat—those which depart least from the straight line being the longest undulations, and those which depart most the shortest undulations. The prism, therefore, it will be seen, possesses the power of separating those vibrations which, when acting in unison, produce the effect of white or homogeneous light, but which, when thus divided, necessarily affect the eye as colour, which has already been shown to be due to the rate of speed with which the vibrations of light enter the organ of sight: those which are least bent out of the direct line being the red rays, which are said to be the least refrangible, while those which are most bent, and are therefore most refrangible, are the blue and violet rays, which will always be found occupying the opposite end of the spectrum to the red.

Nature of refraction.

Rays of different refrangibility.

Red and violet rays.

Certain observations of the solar spectrum made by the father of modern science—Newton—led him to believe that it was not continuous; but Wollaston was the first who succeeded in demonstrating the fact that it actually did exhibit those gaps or vacant spaces whose existence Newton had inferred. Subsequent observations showed that the number of these spaces was very great, and that many of them were of hair-like fineness; and from a

Gaps or dark lines of the spectrum.

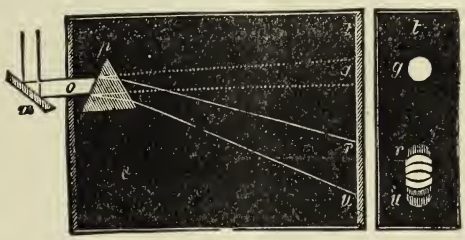
German chemist, who drew up a chart or diagram exhibiting the appearance and position of a number of these lines, they received the name of Fraünhofer's lines.

Frauenhofer's lines.

In order to exhibit these lines in the solar spectrum, a special apparatus, termed a spectroscope, is required. A ray of light, admitted through a narrow slit—a thin slice of sunlight, as Tyndall terms it—is fully decomposed by passing through several prisms, and the spectrum thus obtained is examined through a telescope fitted to the stand on which the apparatus is affixed.

The spectroscope.

For the benefit of those of our readers who may wish to make spectroscopic observations, we may mention that a small but very effective spectroscope, such as may be carried in the waistcoat pocket, is manufactured, and may be had by the student from almost any of the principal philosophical instrument makers.



THE SOLAR SPECTRUM.

The solar spectrum, when viewed through the spectroscope, exhibits those breaks of continuity, or lines, of which we have already spoken, and whose existence was recognized by the scientific world long before their true nature was known. Before attempting to account for the lines of the spectrum, we think it advisable to draw attention to the following facts. If we view the spectrum, or decomposed image of the light of any solid body, when glowing hot, or at the point of incandescence as it is termed, we shall find it to be entire and unbroken; and if the heat be sufficiently powerful to convert the solid into the condition of a liquid—to cause its fusion—the spectrum is still the same. As the body cools the colours of the spectrum gradually begin to vanish at the violet end, while the red is the last to disappear. While the spectra of solids and liquids are thus continuous, however, it will be found that the spectra of incandescent or glowing vapours exhibit a series of bright lines with intervening spaces.

Spectra of solid bodies.

Of liquids.

Spectra of glowing gases.

To vaporize a substance, and to cause its vapour to glow with light, an intense degree of heat—such as can only be obtained from the oxyhydrogen blowpipe, or the electric car between the carbon poles of the battery, is in most cases requisite. Some bodies may however be vaporized at a lower temperature. If a little common table salt be sprinkled upon the flame of a spirit lamp, the flame will instantly assume a pale yellow tint, the light from which, if examined through a spectroscope,—the little pocket instrument will answer every purpose,—will be found to exhibit a spectrum composed, not of a series of brilliant colours, but of a single line or bar of yellow light. This is the well-known line of the metal sodium, one of the constituents of common salt. If we examine other substances under similar conditions, we shall, in like manner, be presented with a spectrum consisting of a series, more or less numerous, of bright lines, the lines being, in every case, characteristic of the body under examination: thus, while sodium gives a yellow band or line, lithium gives two lines, red and orange; thallium—a newly discovered metal—a green line; hydrogen three lines, one red, one green, and one blue; and so on for other bodies, the lines in many cases being far more numerous.

High temperature required to vaporize bodies.

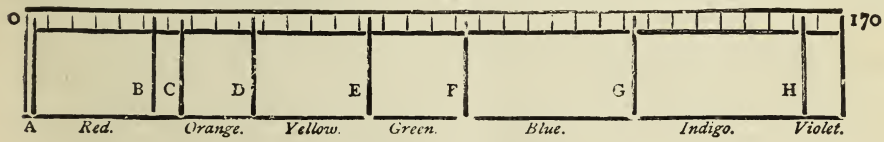
Spectrum of sodium.

Spectra of bright lines.

The important question now suggests itself, What connection, if any, have these lines of light with the dark spaces of the solar spectrum? If we find that the bright lines that characterise the spectra of certain elements can be proved to correspond with the dark spaces in the spectrum of the sun, do we not seem already to hold in our hands the key which shall unlock the secrets of spectrum analysis? In point of fact, the discoveries made in this field of research are based upon the fact that these lines are actually found thus to correspond. Such lines are therefore termed absorption bands, being due to the absorption of a portion of the solar light by the vapours of various incandescent media through which it is transmitted to us. The bright lines in the spectra of the different elements that exist in the solar atmosphere appear in the spectrum of that luminary as dark lines. The process of reasoning by which we have arrived at this conclusion is based upon the following fact: We know that a luminous or incandescent body —whether solid or in a molten state—gives

Connection of the bright lines with the dark spaces of the solar spectrum.

Absorption bands.



EXAMPLE OF THE SPECTRUM.

a continuous or unbroken spectrum if its light be decomposed by a prism, whereas the spectrum of a glowing vapour consists of bright lines. We know, moreover, that if the light of an incandescent solid be passed through the glowing vapour of any substance, its spectrum will be found crossed with dark lines corresponding to the bright lines in the spectrum of the vapour: for example, if the brilliant light from the carbon points of the electric light be allowed to pass through the glowing vapour of the metal sodium, we shall find its spectrum crossed with a black line exactly corresponding with the well-known orange line of sodium. We can thus produce artificially, in the spectrum of the electric light or that of any other incandescent solid, dark lines exactly corresponding to many of those in the solar spectrum. What conclusion do we then arrive at in connection with the sun? Why, that if we could sweep away the glowing vapours that hang like a cloud around the solid body of the sun, the light emanating from the photosphere of that luminary would give us an unbroken spectrum; in like manner, could we cut off the light from the solid sphere of the sun, the whole of the dark lines of the spectrum would instantly be converted into bright lines. Of course we cannot expect ever to witness the first effect; but the second may actually be seen when the luminous side of the sun is entirely covered by the dark body of the moon during a total eclipse. As the moment of totality approaches, the colours of the solar spectrum gradually fade away, and the dark lines, by which it was crossed, flash forth into lines of colour—a deeply interesting fact, and one strongly confirmatory of the truth of the theory of spectrum analysis.

Spectrum of luminous solid or liquid.

Dark lines of spectrum.

Sodium line.

Dark lines artificially produced.

Lines in spectrum due to glowing vapours.

The dark spaces converted into lines of light.

Effect witnessed during an eclipse of the sun.

The dark spaces in the solar spectrum being caused by the interference or quenching power exercised by the bright bands of colour in the spectra of the elements whose incandescent vapours float in the atmosphere of the sun, the appropriateness of the term interference bands, or absorption bands, as applied to the dark spaces so caused, at once becomes apparent. Each bright band or streak in the spectra of the glowing vapour kills or quenches a portion of the sunbeam corresponding in tone or colour with itself which becomes apparent when the sunbeam is spread out as a spectrum. This fact is expressed in scientific language by saying that a ray of light quenches or destroys every other ray of the same refrangibility as itself. In our next article we shall pursue this interesting subject, and speak of Spectrum Analysis as applied to the stars, and of the analogy existing between light and sound.

Lines due to interference.

The theory of absorption by light.

XXIX.

THE PRONOUN (*continued*).—THEORY.

1. THE REFLECTIVE PRONOUN.—To express the idea that the action of the verb passes over to the doer of it—*i.e.* the subject—speech possesses a so-called *reflective pronoun*, which refers back to the subject, or rather *reflects* it. It is evident that this reflective pronoun can never be the subject itself. Its forms for the 1st and 2nd persons are the same as oblique cases of the personal pronoun. For the 3rd person, one word, *se*, does duty for both genders, both numbers, both cases. This pronoun is submitted to the same laws as the personal pronoun. Therefore—

a. The following forms, whether used as direct or indirect objects, must stand before the verb :—

		Direct object.	*Indirect object (by à understood).*
S.	1st *me* (*m'*)	myself	to myself
	2nd *te* (*t'*)	thyself	to thyself
	3rd *se* (*s'*)	himself	to himself
		herself	to herself
		itself	to itself
		one's self	to one's self
P.	1st *nous*	ourselves	to ourselves
	2nd *vous*	yourselves	to yourselves
	3rd *se* (*s'*)	themselves	to themselves

Examples of the direct object :—

Je ME constitue le protecteur de ces enfants, *I constitute myself the protector of these children;*

Tu TE blâmeras d'avoir agi ainsi, *thou wilt blame thyself for having acted thus;*

Le chien SE couche à mes pieds, *the dog lays himself down at my feet;*

Nous NOUS perdrions si nous vous écoutions, *we should ruin ourselves if we were listening to you;*

Nous ne voulons pas que vous VOUS accabliez de besogne, *we do not wish you to overburden yourselves* (or *yourself*, if *vous* is used as the conventional form for the 2nd person singular) *with work;*

Ils s'aiment tendrement, *they love themselves* (also *each other*) *tenderly.*

Examples of the indirect object by à *understood :—*

Je M'adresse des reproches amers, *I address bitter reproaches to myself;*

Tu T'appliqueras ces vérités si tu es sage, *thou wilt apply these truths to thyself, if thou art wise;*

On s'est donné du mouvement pour rien, *one has given trouble to one's self for nothing;*

NOUS nuisons-nous? *are we hurting ourselves* (or *each other—nuire* is an active intransitive verb, to do hurt *to*);

Ne VOUS rendez-vous pas compte de la chose? *do you not realize* (*do you not render to yourselves an account of*) *the thing?*

Les soldats SE répètent les ordres de leurs chefs, *the soldiers are repeating to themselves* (or *to each other*) *their chiefs' orders.*

Remarks.—1. From some of the above examples, it will be observed that the plural of the three persons has not only a reflective, but also a reciprocal force: *nous nous nuisons* means either we hurt *ourselves* or *each other*. To avoid dubiousness, *l'un l'autre*, one another, in its various forms, is employed to mark unmistakable reciprocity: *nous nous nuisons les uns aux autres*. This construction will be explained in its proper place.

2. The verbs which thus govern the reflective pronouns are known as the *reflective* or *pronominal* verbs.

3. The learner will not proceed far in the study of French without discovering many applications for this pronoun. The above examples only point to cases where the reflective construction might more or less

fairly be used in English also; we could mention numerous instances where it renders the corresponding English passive or English active intransitive: these articles *are sold* cheap=ces articles SE VENDENT à bon marché; we *squat* here=nous NOUS ACCROUPISSONS ici, etc.

b. In the imperative affirmative the pronoun must be placed after the verb, and joined to it by a hyphen. The only reflective forms that may appear there are the 2nd sing. *toi* (for *te*), the 1st and 2nd plur. *nous* and *vous*. It has already been pointed out (Vol. I., p. 323) that the genuine French imperative possesses no 1st sing. and no 3rd sing. or plur.

Amuse-toi, *enjoy thyself, but* ne t'amuse pas, *do not amuse thyself;*
Tuons-nous, *let us kill ourselves, but* ne nous tuons pas;
Reposez-vous, *rest yourselves, but* ne vous reposez pas.

In the 3rd person, let the verb be affirmative or negative, the pronoun remains in front, as the 3rd person is invariably taken from the subjunctive: let him rest himself = *qu'il* SE *repose* (*je veux* qu'il se repose); let him not kill himself = *qu'il ne* SE *tue pas*.

When two imperatives come in succession, the latter may have its object-pronoun before it: *prépare*-TOI *et* TE *rends à la ville* = get thee ready and betake thyself to the city; we say *may*, because *prépare-toi et rends-toi* is more usual.

c. Reflective pronouns have also a disjunctive form:

	Singular.	
1.	moi-même,	*myself.*
2.	toi-même,	*thyself.*
3.	lui-même,	*himself.*
	elle-même,	*herself.*
	soi-même *or* soi,	*one's self.*
	Plural.	
1.	nous-mêmes,	*ourselves.*
2.	vous-mêmes,	*yourselves.*
3.	eux-mêmes, elles-mêmes,	*themselves.*

The principle affecting the personal pronouns obtains here; but not only do these forms serve to make indirect objects with prepositions expressed, but they serve to emphasize other objectives and even the subject: *elle travaille pour elle-même* = she works for herself; *je l'ai rencontré lui-même* = I met him himself; *nous l'avons vu nous-mêmes* = we saw it ourselves.

Remark.—Instead of *soi-même* the less emphatic *soi* is frequently met with: *l'amour de soi*=the love of one's self; *il est rare qu'on ne fasse du mal qu'à soi* (Diderot) =it is seldom that people hurt themselves alone; *il faut être soi dans tous les temps* (J. J. Rousseau) = at all times one must be true to one's self; *des passions la plus triste en la vie, c'est de n'aimer que soi dans l'univers* (Florian)=to love but one's self in the world is the saddest passion in life.

2. THE RELATIVE POSITION OF OBJECTIVE PERSONAL PRONOUNS.—A verb—whether it be used affirmatively, negatively, or interrogatively—may govern two objects expressed by personal pronouns; of these the one may be direct and the other indirect, or they may both be indirect. While all objective personal pronouns, taken singly, stand before the verb which governs them, not every one pronoun can precede the verb in combination with every other pronoun; a distinction requires to be drawn.

a. In the combination *direct* + *indirect*, both pronouns may stand before the verb, if the direct object be one of the three *le, la, les.*

EXAMPLES.

On ME LE donne, *one gives it* (or *him*) *to me;*
On TE LA rend, *one returns it* (or *her*) *to thee;*
On NOUS LES prend, *one takes them from us;*
On VOUS LES offre, *one offers them to you.*

It will be seen here that the indirect precedes the direct object; but when both pronouns belong to the 3rd person, the reverse order obtains:

On LE LUI donne, *one gives it* (or *him*) *to him* (or *to her*);
On LA LUI rend, *one returns it* (or *her*) *to him* (or *to her*);
On LES LEUR prend, *one takes them from them.*

b. In the combination *direct* + *indirect*, both pronouns may stand before the verb, if the indirect pronoun is *y* or *en.*

EXAMPLES.

Il M'Y envoie, *he sends me there* (or *to it*);
Elle T'EN ramène, *she brings thee back thence* (or *from it*);
Tu L'Y vois, *thou seest him there* (or *at it*);
Tu L'EN occupes, *thou occupiest her with it;*
On NOUS Y rencontre, *one meets us there* (or *in it*);
On VOUS EN fatigue, *one tires you with it;*
Je LES Y attrape, *I catch them at it.*

In all the above cases the direct object stands first. No combination of *direct* + *indirect* is possible, beyond that of *indirect* with *direct le, la, les*, as shown in *a*, and that of *direct* with *indirect en, y*, as shown in *b*.

c. When the verb governs two objects, of which the one is any other direct than *le, la, les*, the other any other indirect than *en, y*, the direct is put before the verb, and the indirect, in the disjunctive form, with preposition expressed, after it.

EXAMPLES.

one sends	*thee to me*	= on T'envoie À MOI
	me to thee	= on M'envoie À TOI
	you to us	= on VOUS envoie À NOUS
	us to you	= on NOUS envoie À VOUS
one presents	*me to him*	= on ME présente À LUI
	thee to her	= on TE présente À ELLE
	us to them	= on NOUS présente À EUX
	you to them	= on VOUS présente À ELLES

One can, therefore, not say *on te m'envoie, on me t'envoie*, etc.; such constructions would present an ambiguous meaning: *on te m'envoie* might mean, one sends *me to thee*, or one sends *thee to me.*

d. In the combination *indirect* + *indirect*, the indirect objective pronouns may stand before the verb with *en* and *y*, but not with each other.

EXAMPLES.

il	M'EN donne, *he gives me some* (*of it* or *of them*);
	T'EN prend, *he takes some away from thee;*
	LUI EN vole, *he steals some from him* (or *her*);
	NOUS EN rend, *he returns some to us;*
	VOUS EN parle, *he speaks of it* (*him, her, them*) *to you;*
	LEUR EN procure, *he gets some for them.*
on	M'Y rappelle les faits, *one recals the facts to me there;*
	T'Y attache le ruban, *one attaches the ribbon to you there* (*to it*);
	LUI *
	NOUS Y parle de tout, *one speaks of all to us there;*
	VOUS Y conte des histoires, *one tells stories to you there;*
	LEUR Y fait des tours, *one performs tricks to them there.*

* *Remark.—Lui y*, on account of the hiatus, is inadmissible: *one gives him cares there* might be rendered by *on lui donne des soins là; on lui donne des soins en cet endroit; il y reçoit des soins*, etc.

e. When the verb governs two indirect objective pronouns, neither of which is *en* or *y*, the indirect object with *à* understood (*dative*) comes before, and the other, with a preposition expressed, goes in the disjunctive form after the verb:

she speaks
- *to me of thee*, elle ME parle DE TOI;
- *to thee of me*, elle TE parle DE MOI;
- *to him (her) of you*, elle LUI parle DE VOUS;
- *to us of you*, elle NOUS parle DE VOUS;
- *to you of me*, elle VOUS parle DE MOI;
- *to them of us*, elle LEUR parle DE NOUS.

Remark.—Where the use of *en* creates ambiguity, the disjunctive form removes it; if we say *elle en parle*, this may mean she speaks of it, of him, of her, or of them; by saying *elle parle* DE LUI, *elle parle* D'ELLE, *elle parle* D'EUX, *elle parle* D'ELLES, all doubt as to the antecedent is removed.

f. Both *y* and *en* may be governed by the verb, and stand before it.

EXAMPLES.

NOUS Y EN prendrons, *we shall take some of them away from there;*
ON NOUS Y EN a promis, *one has promised us some there;*
VOUS LEUR Y EN enverrez, *you will send some to them there.*

g. When the verb governs a reflective pronoun and a purely personal pronoun, both may stand before the verb, provided the personal pronoun be one of these five —*le*, *la*, *les*, *en*, *y*; no other pronoun can so be placed with the reflective. Of the two the reflective pronoun comes first.

EXAMPLES.

je ME LE rappelle bien, *I well recall it to myself;*
tu TE LA figures ainsi, *thou picturest her so to thyself;*
il SE LES applique, *he applies them to himself;*
nous NOUS EN parlons, *we speak of it to ourselves;*
vous VOUS EN racontez les détails, *you relate the details of it to yourselves;*
ils s'Y amassent du bien, *they gather there wealth to themselves.*

(In the above examples the reflective pronoun forms an indirect object. In the following it is direct.)

nous NOUS Y adonnons, *we give ourselves up to it;*
vous VOUS EN moquez, *you mock yourselves of it (laugh at it);*
ils s'Y appliquent, *they apply themselves to it.*

FIG. 193.—ASH TREE.

h. Any indirect object other than *en* and *y* would appear after a reflective verb in the disjunctive form, with its preposition expressed. Even *en* and *y* would be so changed if any doubt existed as to their antecedent.

EXAMPLES.

elle s'est adressée À MOI, *she has addressed herself to me;*
on s'est occupé DE TOI, *one has busied one's self about thee;*
tu T'es confié À NOUS, *thou intrustedst thyself to us;*
elle s'est soumise À VOUS, *she has submitted (herself) to you.*

And to remove the ambiguity which *y* and *en* might present, say—

je ME fie À LUI	elle s'occupe DE LUI
tu TE fies À ELLE	nous NOUS occupons D'ELLE
il SE fie À EUX	vous VOUS occupez D'EUX
on SE fie À ELLES	ils s'occupent D'ELLES.

While satisfied that the above rules on the relative place occupied by objective pronouns will prove useful to most minds, we are painfully aware of their length, and therefore append a summary table for the benefit of those who put their trust in the *rule of thumb*.

The following scheme points out the order of precedence of objective pronouns when they may appear before the verb at all: those in column 1 always precede those in 2, 3, or 4; those in 2 precede those in 3 or 4, etc.

1.	2.	3.	4.	5.
me	le	lui	en	y *before*
te	la	leur	y	en.
se	les			
nous				
vous				

BOTANY.

XXXVI.

VARIOUS ORDERS (*continued*).

THE singular and often beautiful flowering plants which constitute the order of the Apocynaceæ are represented in England, out of doors, by the common periwinkle, *Vinca major*, the delicate violet-blue corollas of which stand in contrast so rich, in early summer, with the deep green and shining foliage. There are other members of it, in plenty, in greenhouses and hothouses —the magnificent Allamandas, to wit, the equally grand Dipladenias, and that lovely half-sister of the periwinkles, the *Catharanthus*; and in botanical gardens there are species, at times, of true Apocynum. It is to the periwinkle, nevertheless, that it is best, as well as most convenient, to look for information as to the characteristics of the group as a whole. These consist in the opposite leaves, simple and undivided, and without stipules; and the monopetalous, pentamerous, and regular flowers, with five epipetalous stamens and a solitary and superior ovary. The very special and curious mark of the order is found in the style and stigma. Dissect a periwinkle flower with care, and below the stigma proper there will be found a remarkable expansion, making it seem as if there were *two* stigmas, one above the other. The periwinkle fails us in only one particular. It seldom ripens its *seed-pods*, at all events in England; and to possess these, as we have already seen, is indispensable to a full and thorough conception of a family. But the greenhouse and garden species are equally reticent—except, perhaps, in the case of the common dogs' bane, *Apocynum androsæmifolium*, from which, when the opportunity offers, we may learn that the fruit in this order is a remarkable two-valved capsule, the numerous

seeds provided, very generally, with a delicate wing, something like that of the thistle seed. The Apocynaceæ are natives chiefly of warm countries. All are herbaceous; many are climbers or twiners; and one with another they are to be considered rather dangerous, though many are quite harmless. The name Apocynum, in literal translation "dogs' bane," refers to the very ancient reputation of the plant as a poison.

The Asclepiadaceæ.

The Asclepiads have no example whatever among our indigenous British plants. So beautiful, however, or so quaint, are many of the tropical and sub-tropical species, that they are very general favourites with the gardener who can give them a kind of imitative climate. Few ladies are unacquainted with the matchless Stephanotis, the Madagascar chaplet-flower, white as pearl and fragrant as lilies. Every good conservatory is possessed of its Hoya, or wax-flower, from the clustered stars of which the honey falls literally in drops. The cultivators of the odd and anomalous are, for their own part, never without examples of the wonderful Stapelias, or star-fish flowers of the southernmost parts of Africa. These extraordinary freaks of nature have no proper leaves; resembling, in some degree, the cereuses of the cactus family, for which, when not in bloom, they might readily be mistaken. When the flower opens it is a beautiful star, often two or three inches in diameter, exceedingly varied in colour, though never blue, and so suggestive, in its shape and hue and animal physiognomy, of the strange inhabitants of the sea-margin called star-fishes, that the name is quite legitimately borrowed. They supply a striking illustration of the echoes with which nature abounds,—no fact being more palpable to the exact observer than that plant and animal, flower and insect, bird and blossom, constantly reiterate a primary idea, each in its own way taking up, in a different mode, some simple and pretty design, and delighting to show us in how many keys the old tune can be sung, the old tale recited. The Stapelias go a step further than the star-fishes, being sometimes invested with a delicate mantle of silk. Now for the strict botanical characters. All through this wonderful order there is an exquisite maintenance of the pentamerous idea in the flower. The stars are more symmetrical than in any other section of floral nature,—with the five rays there always go five stamens,—the corolla is monopetalous; there are two united ovaries, and to these last the stamens *adhere*, so that we have the condition termed *gynandrous*.

FIG. 194.—CYPRESS. OLIVE TREE.

Two families alone, among the Exogens, have gynandrous flowers—the Aristolochias, in which the blossoms are either hexamerous, or else intensely irregular; while in the Asclepiads, as said before, they are consummately pentangular. Nothing is easier, therefore, than to determine the family of an asclepiadaceous plant. No trees occur in this order, but many shrubs. A few yield a milky juice, which can be converted into india-rubber. Others are poisonous, or at all events suspicious. None can be called esculent.

The Solanaceæ.

The very name of the Solanaceæ, or "Nightshade Family," carries with it a kind of "Beware!" For, beautiful as it is, and in many instances profoundly, yea, unspeakably useful to man, it abounds also in deleterious and even malignant plants. "Nightshade" is almost a synonym for "poison," and in the particular kind which bears the famous and classic name of "Atropa"—that one of the three sisters who "cut the thread of life"—it is only too well founded. "Atropa Belladonna," is the fearful "Deadly Nightshade," noted alike in fable and in melancholy fact.

The order is one of the large and varied ones, containing shrubs and a few small trees, though the mass of it is herbaceous. Being diffused almost all over the world, five species, or thereabouts, are accounted wild in Britain. There is considerable diversity in the outline of the leaves, though, as a rule, these parts are simple and undivided: in any case they are alternate and exstipulate. The flowers are almost invariably pentamerous and regular. The petals are more or less united—sometimes, as in the Solanums, presenting a beautiful five-rayed star, but often, as in the Habrothamnus, tubular. The five stamens are epipetalous; the ovary, solitary and superior, ripens either into a berry or a capsule, which in either case is two-celled, or imperfectly four-celled, and contains great abundance of seed. The association of a fruit of this kind with flowers such as described is peculiar to the Solanaceæ, and hence forms their absolute distinctive character. Many kinds of inflorescence occur; the flowers, in the various species, are of all the accustomed colours; and the fruits present an almost equally beautiful diversity.

XXXV.

The Conjunction.

§ 215. Derivation of Conjunctions:
§ 216. from Pronouns,
§ 217. from Adverbs,
§ 218. from Prepositions,
§ 219. from Verbs.
§ 220. Co-ordinatives.
§ 221. Co-relatives.
§ 222. Sub-ordinatives.
§ 223. Examples of conjunctions connecting—(*a*) compound sentence; (*b*) complex sentence.
§ 224. Examples of the various uses of one word.

§ 215. Conjunctions, the words which join sentences together, do not undergo inflexion: they are derived from other classes of words; even those which seem short and simple, such as *yet*, *if*, *yea*, *and*, we are told have their origin anciently among the pronouns. We will note the principal sources of conjunctions, some of which have been already shown.

The old conjunction *an*, now out of use, comes from the same root as *and*. It is found occasionally in Shakespeare; Benedict says, "Go to, i' faith, *an* thou wilt needs thrust thy neck into a yoke, wear the print of it."—*Much Ado*, Act I., sc. 1. *An* means *if*; compare it with the second *and* in the quotation from 1 Cor. xiii., in § 223 *b*. Sometimes old writers use *an if* together.

§ 216. From **Pronouns** we get several pairs of conjunctions: *either—or*, *neither—nor*, *as—as*, *so—as*, *what—what*. The conjunctions *or* and *nor* are contractions from *either* and *neither*; this is shown by instances in Middle English, where the kindred words *other—other* are used for *either—or*.

"Oper þat a scholde leue þe kyngdom, *oper* holde the kyngdom of duc William."
John of Trevisa, A.D. 1387.

[Either that he should leave the kingdom, or hold the kingdom of Duke William.]

Examples of the use of these pairs:

"*Either* I mistake your shape and making quite,
Or else you are that shrewd and knavish sprite
Called Robin Goodfellow."
Mids. N. Dream, Act II., sc. i., l. 32.

"I have *neither* gowd *nor* land."
Ballad, *Huntingtower*.

"*As* far *as* eye could see."
C. Kingsley, *The Sands o' Dee*.

"*So* long *as* man can breathe, *or* eyes can see."
Ballad.

What with the dust, *what* with the sun, he could scarcely see.

As—so (*so—as* reversed) are adverbs; e.g., "*As* the hart panteth after the water-brooks, *so* panteth my soul," etc.—Ps. xlii. 1.

Besides these pairs, we have from pronouns *eke*, *also*, *else*.

The *demonstrative the* is the root of *that*, *though*, *although*, *than*, *then*, *therefore*.

The *relative* root *who* is found in *where*, *whereas*, *wherefore*, *why*, *while*, *when*, *whether*, *what*.

Observe that most of these have occurred before as adverbs (see §§ 93, 207). It is useful to remember that they join complex sentences, and as a consequence are followed by the verb in the subjunctive mood (see § 199).

§ 217. Many other *Adverbs*, formed both from (1) Nouns, and (2) Adjectives, are used as conjunctions—as (1) *likewise*, *while*, *whilst*; *because* and *besides* are more strictly conjunctions, formed after the manner of noun-adverbs; (2) the pairs *both—and* *now—anon*, *not only—but also*, *even*, *only*, *furthermore*, *moreover*, *lastly*, *firstly*, etc. Three are compounds with *less*, comparative of *little*—i.e. *lest* (shortened from the phrase *thy læs the*); *nevertheless*, formerly *natheles*; *unless*, from *on-lesse*.

§ 218. Several *Prepositions* come in at times as conjunctions, the chief of which are *but*, *till*, *until*, *since*, *for*, *for-to* = in order to.

"Simple Simon went a fishing
For to kill a whale."—*Nursery rhyme*.

§ 219. Lastly, some highly useful conjunctions and phrases used to join sentences proceed from parts of *Verbs*—as *say*, *suppose*, *considering*, *provided*, *except*, *saving*, *howbeit*, etc.

§ 220. Conjunctions are often classified into six or seven sorts, according to their meaning; we shall not trouble the student with these; it is more needful for practical use to keep in mind the two divisions according to their value,—the **Co-ordinatives**, those that join sentences of equal or independent power (*compound* sentences); and the **Sub-ordinatives**, those that join sentences of unequal power, a principal and a dependent clause (*complex* sentences; see before, §§ 98, 99).

§ 221. These that go in pairs are called **co-relatives**. *Note*, that it is only as *part of a pair* that the pronoun or adjective member of a co-relative can be said to be a conjunction; thus, in "he is *either* mad *or* ill," *either—or* join "he is mad" to "he is ill," but in "I will have *either* of you," *either* is pronoun; in "she scolded *both* Tom *and* Harry," *both—and* join two similar sentences, while in "*both* of you are wrong," *both* is adjective.

The following words, co-relatives and conjunctive phrases, join **co-ordinate** sentences, and are *not* followed by the subjunctive mood of the verb:—

and	still
but	therefore, wherefore
besides	whereupon
or [see § 214 (4)]	accordingly
also	consequently
likewise	hence
moreover	then, than
further	both—and
otherwise	not only—but
else	either—or
only	neither—nor
nevertheless	on the one hand—on the other hand
notwithstanding	as well as
however	and so
yet	

§ 222. The following words, co-relatives, and conjunctive phrases join **sub-ordinate** clauses to principal sentences, and, as they add to the

meaning as well as connect the sentence, they are sometimes called *continuatives;* the dependent or sub-ordinate clause should usually take its verb in the subjunctive mood.

as	except
before	though, although
after	lest
while	so
until, till	though—yet
when, whenever	whether—or
where	as—as
whither	as though
whence	as long as, as often as
what	inasmuch as
that	as soon as
because, for	seeing that
if	in order that
unless	so that
since	considering

There may be a few others not included in these lists; they will be recognized on examination. A few given above, such as *than*, *for*, and *because*, belong to both classes.

§ 223. A few examples may aid the student in distinguishing between compound and complex sentences, and to understand the proper conjunctions; to which shall be added some instances exemplifying the same word in use as several parts of speech.

(*a*) *Compound* sentences:

"He had *not only* no designs on your pocket, *but* would not be easily duped by designs on his own." BULWER LYTTON.

"The population of London is little more *than* six times the population of Manchester" [is]. MACAULAY.

"We are rather late, *and* it won't do to keep him waiting." DICKENS.

He is learned and good, *yet* he is poor.

(*b*) *Complex* sentences:

"Do take another slice, *for* you do not get pudding every day." CHARLES LAMB.

"Think of the circumstances of mankind *when* languages began to be formed."—BLAIR.

"Kings have no right divine *except* when [they are] deposed and fallen." BULWER LYTTON.

"His cheek, *though* [it were] not highly coloured, was *yet* ruddy and clear."—*Ib.*

"He was glad to turn away from the stage *while* Orestes was raving." MACAULAY.

I should not go *if* I were you.
She will not sing *since* it is so late.
I cannot tell *where* he may be.

"*Inasmuch* as ye have done it unto one of the least of these my brethren, ye have done it unto me."—Matt. xxv. 40.

"*Though* I speak with the tongues of men *and* of angels, *and* have not charity, I am become as sounding brass, *or* a tinkling cymbal."—1 Cor. xiii. 1.

Here are both kinds of sentence:—

Compound, 1st co-ordinate, "I am become as sounding brass."
2nd co-ordinate, [I am as] "a tinkling cymbal."

One of these serves as *principal* clause for a *complex* sentence, the first dependent clause of which is introduced by *though*, the second by *and*, which here means *yet* or *if*.

Principal: "I am become as sounding brass" (though).
Dependent: "I speak with the tongues of men" (and).
[I speak with the tongues] "of angels" (yet).
2nd dependent: [I] "have not charity."

By this it will be perceived that the conjunction *and* allows clauses and sentences to be contracted; by its use a great deal of repetition is avoided, and the previous part of a clause, as the words in [ ], are understood to be meant. A conjunction frequently is found at the beginning of a sentence, apparently belying its name and joining nothing; but this is often owing to the inversion of the clauses, as in the two last examples.

§ 224. *Various uses of one word.*

Since, adverb: That was finished long *since* (= ago).
„ preposition: We have been away *since* Monday.
„ conjunction: He has eaten nothing *since* he has been ill.

But, adverb: She is *but* a child.
„ conjunction: We are hungry, *but* we are willing.
„ preposition: They are all gone *but* me (*i.e.* except).

Before, preposition: The boy stands *before* the window.
„ adverb: "As I wrote a little *before*."—Ephes. iii. 3.
„ conjunction: "Now I tell you, *before* it come."—John xiii. 19.

As, pronoun: It's him *as* is to blame (see § 162 *e*).
„ conjunction and adverb: "*As* for man, his days are *as* grass."—Ps. ciii. 15.
„ conjunction: Is she good *as* she is fair?

Whither, adverb: *Whither* hast thou flown?
„ conjunction: *Whither* thou goest, I will go."—Ruth i. 16.

While, noun: All the *while* I was at home
„ adverb: He grows old *meanwhile*.
„ conjunction: I cannot go *while* you are here.

Still, noun: A *still* for Irish whiskey.
„ adjective: This is *still* champagne; "Beside the *still* waters."—Ps. xxiii. 2.
„ adverb: She is *still* there; Lie *still*.
„ conjunction: I do not like this, *still* I must take it.

XXXII.

GREECE.

THE Greeks originally formed part of a people dwelling in Asia, between the Caspian

Sea and the mountains west of India. As this nation gradually increased in numbers and became too populous for its territory, parts of it separated from the parent stock and wandered in different directions in search of "fresh fields and pastures new." The Greeks, as well as almost all the nations of Europe, are the descendants of these wanderers, while the inhabitants of India are descended from another set of wanderers from the same parent stock. The Greeks, or Hellenes as they always called themselves, came south, some settling in what is now Greece, others establishing themselves on the coasts of Asia Minor and the adjacent islands.

Origin of the Greeks.

The first Greeks were a peaceful people, occupying themselves with agriculture. The country was divided into numerous small states, each governed by a king, who was like a chief of a tribe more than what we now understand as a king. Many of the islands in the Greek archipelago were colonised by the Hellenes. These islanders and their fellow-countrymen on the coast of the mainland soon fell in with the Phœnician mariners and merchants from Tyre and Sidon, from them speedily acquired some knowledge of navigation and ship-building, and in process of time learned all that the Phœnicians could teach them. The Phœnicians possessed a higher degree of cultivation than the Greeks at first, but the latter quickly became their equals in this respect. The Greeks soon turned their newly acquired knowledge to good account, and began to scour the Mediterrean at first as pirates, afterwards as traders.

The first Greeks.

Phœnician merchants.

We have very few authentic accounts of Greece in early times. Much of what is handed down to us must be looked upon as mere fable, beautifully and poetically told. The chief sources of our earliest information are the two great poems called "The Iliad" and "The Odyssey." These were believed by the Greeks to be the works of a single man, Homer; and are undoubtedly among the very greatest epics the world possesses. "The Iliad" describes the ten-years' siege of Troy or Ilion, a town and castle at the south end of the Hellespont (Dardanelles). "The Odyssey" is an account of the travels and wonderful adventures of Odysseus or Ulysses, king of the island of Ithaca. These, even though they cannot be taken as true accounts of the events they pretend to relate, are yet most valuable from the insight they give us into the government and condition of the Greek states in very early times, and the social and religious life of the people. We find that the government of each little state consisted of a chief or king, who was also the chief priest, and a council of elders. The people were never consulted, but when action was decided on they were assembled and told what had been determined. We find, as we might expect, much that was savage and cruel and treacherous in their modes of warfare; but we also find much that was noble and truly heroic. In their domestic life especially we find family affection and reverence for parents. Women, too, were treated with far greater deference and tenderness than among their contemporaries in the neighbouring countries, and many of the most highly honoured of the Greek deities were represented as women. The Greeks worshipped many gods and goddesses, whom they represented as men and women of the most beautiful and majestic ideal types. They attributed to them all the physical, mental, and moral qualities of men and women, but in a higher degree, and they believed them to be immortal. Every particular spot, and many natural objects, were believed to be watched over by a particular deity, who was worshipped with prayer and sacrifice.

Homer.

Historical value of the Iliad and Odyssey.

Glimpses of early Greek life.

Deities.

Before very long, one of the northern tribes, called the Dorians, left their own province and invaded southern Greece, which was called the Peloponnesus, compelling the inhabitants, who were called Ionians and Achaians, to fly before them. Many of these sailed away to Asia Minor, and established new colonies there. But though the Dorians were successful in their invasion, they were not numerous enough to subjugate the entire Peloponnesus. Arkadia, a mountainous district in the centre of the country,—the Switzerland of Greece,—remained undisturbed, both then and for long afterwards, so that "Arcadian" came to mean "rustic simplicity." The Achaians also dwelt in peace on the north coast. By degrees the Dorians conquered nearly the whole of Peloponnesus. Sparta was the most famous of their strongholds. They allowed the conquered inhabitants no share in the government. They were divided into two classes: the first of these, the Periœki, were allowed to keep their own farms; and the second, the Helots, were serfs, and were obliged to till the ground for the Spartans. They were so cruelly oppressed that they were constantly in a state of rebellion, and entertained the fiercest hatred for the Dorians. The conquerors, having no agricultural duties to employ them, and being in daily fear of a revolt amongst the Helots, devoted all their energies to making themselves perfect soldiers. We shall hereafter see what severe self-denial they had to submit to in order to attain this end.

Dorian invasion of Peloponnesus.

Growth of the Grecian States.

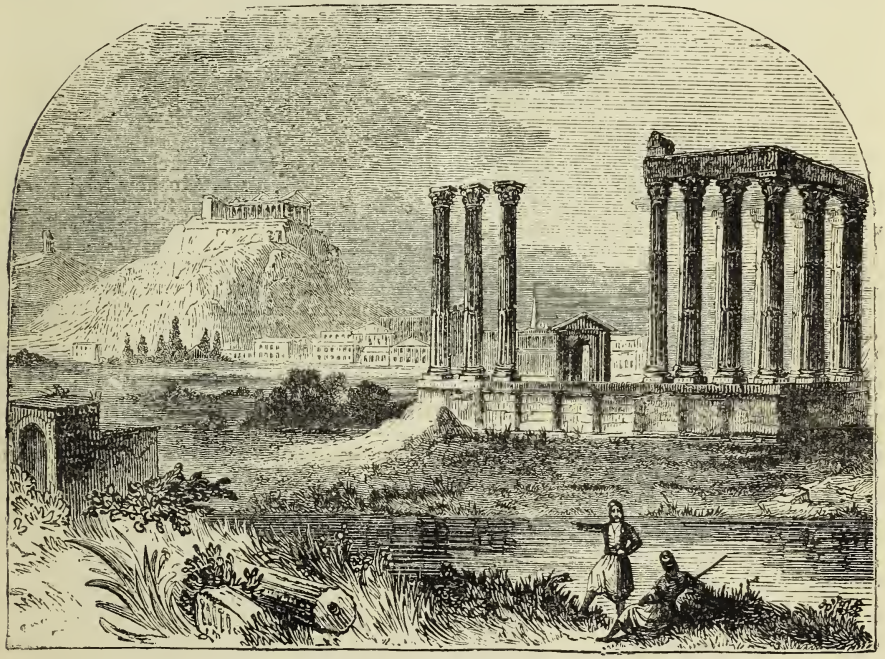
From the first Olympiad to the commencement of the revolt of the Ionic Greeks from Persia (B.C. 776 *to* B.C. 500).

It is not until after the Dorian invasion that we are able to construct anything like a continuous history of Greece. In studying that history it must never be forgotten that it is the history of a number of very small states politically independent of each other. It is not, as in the case of Rome, the history of the gradual development of one state and the

Greece a country of many small states.

gradual absorption and union of sister states and neighbours. So small were these Greek states that they were often nothing more than a single town of a few thousand inhabitants, together with a few square miles of the country immediately around it—not as large as the estate many an English landlord of the present day owns in a single English county; and probably none of these states, even the largest, at the height of its power, ever owned a larger tract than an English county. And each of these tiny states was quite independent of the others. Occasionally for purposes of defence a number of them would join their armies and temporarily submit to a sort of political union, but only in respect of foreign affairs, and the league was broken up as soon the temporary

simply "unintelligible people," *i.e.* foreigners, and gradually came to imply the dislike and contempt which they associated with such foreigners, and which was partly justified by the want of refinement exhibited by their "barbarian" neighbours. Had the Greeks been able to unite, and had some state such as Sparta or Attica taken the lead and either forced or induced the other states to submit to a close political union under one head, the history of Greece would have been very different, and she would probably have repelled with ease her Macedonian invaders, and might possibly have preserved her liberty against Rome. But such union was impossible for the the Greeks; and although independence of each other was perhaps the happiest condition



RUINS OF ANCIENT ATHENS.

object was gained. The whole tenor of their ideas and sympathies was vehemently hostile to political union. The citizen of a Greek state confined his patriotism exclusively to his own city. For it he was taught, and willingly submitted, to give up property, personal convenience, home ties, aud even life itself. But beyond the limits of his own little state patriotism came to a sudden stop. The people of a neighbouring state, though they were the same in blood, language, early traditions, manners, festivals, and religious observances, were nevertheless considered as foreigners and generally as enemies. It is true they did not feel quite the same contempt and hatred for each other as they felt for states outside Greece. These they called "Barbarians,"—a term which originally meant

Greek patriotism

"Barbarians."

for them so long as they were unassailed by any great outside power, it was a fatal weakness when their day of trial came, and made their conquest a comparatively easy matter, as we shall hereafter see. The state which appears to be least open to this charge was certainly Athens. In the hour of deadly peril, when the Persian hosts seemed about to overwhelm not only Athens, but all Greece, she earnestly urged Sparta to forget her ancient rivalry, and herself showed a splendid example of magnanimity by giving to Sparta the chief command of the united fleets, although these were composed almost exclusively of the ships of Athens and her allies, with very little addition from Sparta. Yet, even in this supreme moment, Sparta acted selfishly, and showed little concern for Greece provided Peloponnessus was let alone.

IX.

Newton's Second Law (*concluded*).—Newton's Third Law.

§ 38. A few words now as to the measurement of the force with which we earthly beings have most to do—the force with which the earth attracts a body, or the weight of a body. We have already seen how this may be done with the help of Atwood's machine; but if you have followed my advice to try experiments upon this instrument you will have found that the results are not so consistent as they might be. It is possible by various contrivances—starting the experiment by electricity, making the apparatus itself register the time of the experiment, and so on—it is possible to make Atwood's machine give very good results; but there is always a serious objection to it in the fact that any mistake in the experiment must be made greater by the calculations. And, to find the acceleration produced by gravity, or to find how many poundals there are in the weight of one pound, the *pendulum* is used. You have already seen that the longer the pendulum is, the greater the time it takes to swing (§ 31). I want now to show you that the time of a swing depends also upon the force; but I shall only be able to give you a very rough idea upon the matter. Looking at a pendulum when at the end of its beat, we see it begin to fall by reason of its weight: and it is pretty clear that if we could increase the force (without giving the force a greater mass to move) the pendulum would move faster, and would complete its swing more quickly. So that the time of a pendulum's swing depends upon the length of the pendulum and upon the force that makes it move. Now, mathematicians have found out the relation between these quantities, so that when the length of a pendulum and the time it takes for its swing are known, it is easy to calculate the force. It so happens that the length of a pendulum can be measured with very great precision (although it is not such a simple matter as at first appears). The same is true of the time of a swing: for we may time not one swing, but a hundred swings, or a thousand, or even more. When we have determined these quantities, it is a matter of simple arithmetic to find the force. In this way it is found that the force with which the earth attracts a pound of matter is about 32·19 poundals at London, 32·18 poundals at Paris, while at New York it is less than 32·16 poundals. At the bottom of a deep shaft Sir G. B. Airy found it was greater than at the top. In short, a pound weighs sometimes more and sometimes less, according to the place at which it is; and this fact of itself is sufficient to condemn the use of a "pound" as a measure of force, quite apart from the further disadvantage of encouraging the confusion between "mass" and "weight."

Use of the pendulum.

It may be well to remark that in an ordinary balance this difference of weight cannot show itself. A pound of sugar weighs more at London than at New York; but so does the piece of metal which counterpoises it. In a spring-balance, on the other hand, the difference might be seen if the balance were sufficiently delicate; because a pound of sugar at London would stretch the spring more than it would at New York. But the difference is scarcely great enough to make a commercial application very profitable.

And here our remarks upon Newton's second law of motion must close: we now pass to a very brief account of the third law.

§ 39. Most things can be looked at from two different points of view, and will be called by different names accordingly. The result of a contest is called a "victory" by one party, but a "defeat" by the other side; what the shopkeeper would describe as a "sale" is regarded by the customer as a "purchase"; a "loss" to one may be a "gain" to another. It is the same with forces. Take, for example, the case of an engine drawing a train, or a horse pulling a cart. How shall we describe the tension in the couplings? Evidently this force pulls the train forwards; at the same time it pulls the engine backwards, for if the coupling were to break the carriages would go more slowly and the engine would go faster. If we consider the action of the force upon the train we should say it was a forward force; but looking at it as acting upon the engine, we should describe it as acting in just the opposite direction. Again, consider the case of a book lying upon a table. In what direction is the pressure? The book presses the table downwards—the table presses the book upwards. In each of these cases it must be remembered that there is only one force, and that the difference of description arises entirely from the fact that we may consider the action of the force on either of the two bodies concerned.

The Third Law of motion.

This statement is included in Newton's third law of motion: viz., *To every action there is always an equal and opposite reaction; or the mutual actions of any two bodies are always equal and in opposite directions.* It will be observed that "action" and "reaction" are not different things: they refer to one and the same force viewed from opposite standpoints.

§ 40. But the explanation is not yet complete. We only know of forces by the effects they produce, and it is as well that we should see what this law means when we consider the changes of motion produced. In this way we shall be led to some very important results. You will remember that we measured a force by the change of momentum it produced in a given time; and we shall now see that the law holds good when we suppose "action" to mean the change of momentum produced in one of the bodies, and "reaction" that produced in the

Second explanation of the law.

other. Perhaps the easiest way of doing this will be by an example. Suppose two balls upon a smooth table, one of which is moving straight towards the other which is not moving. Let us inquire what will happen when they come into collision. We will take it that the mass of the ball at rest is 2, and that the other one has a mass of 3 and is moving with a velocity of 10; so that the momentum of the moving ball is 30, that of the other is 0. When the two balls touch they will be compressed for a short time. Then if they are not "elastic"—that is, if they keep the shape given to them in the collision—they will move on together with a velocity 6. Let us see the changes of momentum that have been caused by the pressure between them. The momentum of the big ball was 30 before, and now it is 3 times 6, or 18: so that it has lost 12 units of momentum. On the other hand, the smaller ball, which had no momentum to begin with, has gained a momentum 12. On one of the balls the effect of the force was to produce a *loss*, on the other a *gain* of momentum, and the loss was just as great as the gain. If the balls happen to be "elastic," there is a rebound immediately after the compression. The pressure between the two balls continues, and a further change is produced in the momentum of each. When the balls are perfectly elastic, just as much momentum is lost or gained in this rebound as in the period of compression. So that the big ball would lose and the small one would gain just 12 units of momentum; the larger one getting a velocity of 2 while the small one obtains a velocity of 12. If they are not "perfectly" elastic (as they never can be) the change during the rebound is not so great; but whatever it may be, it will be found that the momentum gained by one is just equal to the momentum lost by the other.

In this way of looking at the third law, "action" and "reaction" refer to different things. "Action" is the change of momentum produced in one body; "reaction" is that produced in the other.

§ 41. There is a third and still more important interpretation of this law. It is at bottom the same as the second, the difference being in the mode of measuring the force. Hitherto we have estimated a force by the change of momentum produced in a certain time—one second. We will now measure by a change produced as the moving body passes over a distance of one foot. The change in question is a change of what is called *vis viva*, or "energy of motion." We will explain first what is meant by this, and then show by examples that it gives the same measure of a force as we got before. To determine the energy of motion of a body, we must know the velocity and the mass of the body. The velocity is to be multiplied by itself; this product is to be multiplied by the mass: and half the result is the energy of motion. We may express this in an equation. If E stands for "energy of motion," m for mass, and v for velocity, then

Third explanation. Energy.

$$E = \tfrac{1}{2}\, m.\, v.\, v.$$

Suppose a body of mass 5 is moving with velocity 6. The velocity multiplied by itself gives 36; this multiplied by the mass makes 180; half of this is 90; and thus the energy of motion in this case is 90.

To show that we get the same measure of force as before, we will take an example of a body falling freely. Suppose its mass to be 4 lb., the force acting upon it is 4 times 32—or 128—poundals. Its energy to begin with is 0, if it starts from rest. Let us find its energy at the end of a second. Its velocity then is 32 (§ 35), and its energy therefore must be 2048. But in this second the weight will have fallen through 16 ft. (§ 13); so that the change of energy *per foot* is one-sixteenth of 2048, or 128, as before. Suppose we had found the energy at the end of half a second, we should have got the same result. For the velocity at the end of the half-second is 16, therefore the energy is 512. In this time the body falls 4 ft. (§ 13), so that the change of energy per foot is 128, as before. By trying other examples you will get further confirmation of our statement that a force may be measured by the change of energy produced *per foot* of the distance the body moves; and should this not satisfy you, you may try to prove it from the equations already given—a matter of very little difficulty if you are well up in algebra.

We will now see if the third law holds good: and first let us take the case of the "perfectly elastic" balls of which we spoke in § 40. The energy of the ball whose mass is 3, when moving with velocity 10, is 150: that of the ball at rest is *nil*. After the collision the large ball moves with velocity 2, and its energy is therefore 6. It has lost 144 units of energy. On the other hand the smaller ball, whose mass is 2, is moving with the velocity 12, and its energy is therefore 144. It has gained just as much energy as the other had lost, and the law is true.

But, as we remarked before, "perfectly elastic" bodies do not exist, and if you try the case of the inelastic or imperfectly elastic balls, you will find that the one loses more energy than the other gains. There is an apparent exception to the law: but it is apparent only, and the examination of this point has led to what is perhaps the most important advance in physical science that has been made since the time of Newton. To give some idea of the nature of the explanation given by Newton himself—an explanation only different from our present solution in that it is less complete—we must say a few words about work.

§ 42. When you lift a heavy body you do "work": a certain amount when you lift it one foot; double that amount if you lift it two feet; and so on. The work also depends upon the weight of the body: if the weight be doubled the work also is doubled. Let us call the work done in lifting a body whose weight is 1 poundal to a height of 1 ft. a "foot-poundal."* Then, for

Work.

* The unit of work commonly used by engineers is the "foot-pound." The objections to this are just the same as to using a "pound" for a measure of force. It may be taken that a foot-pound is practically the same as 32 foot-poundals.

instance, the work done in lifting to a height of 3 ft. a body whose weight is 4 poundals would be 12 foot-poundals; we have only to multiply the weight by the height. It is not, however, to be supposed that "work" is confined to the case of lifting heavy bodies: whenever a body is made to move in opposition to any force, "work" is done: and the amount of work is found by multiplying the force by the number of feet the body moves in opposition to the force.

There is a very important distinction to be made. If a body moves in the direction of the force, work is said to be done *by* that force: if the body moves in the opposite direction to the force, work is done *against* that force. Suppose a body weighing 1 poundal is lifted by you to a height of 1 foot. Then 1 foot-poundal is done *by* you *against* the weight of the body. If you allow the body to sink 1 ft. (pulling at it so as to prevent it gaining in velocity), then 1 foot-poundal is done *by* the weight of the body *against* your pull.

§ 43. And now we can understand Newton's explanation. He takes the "action" of a force to be the work done by that force: the "reaction" is partly the work done against resistances, such as friction, or cohesion, or other forces that act on the body; and, partly, the energy of motion gained by the body: then action and reaction will be equal and opposite.

Third explanation (continued).

As an example of this, let us take a body whose mass is 5 lb., allowed to fall freely. Suppose it has been falling for 1 second. It will have fallen 16 ft., and its velocity will be 32. The force acting upon it is 160 poundals, and therefore the work done by the force is 2560. This may be taken as the "action." Now take the "reaction." There are no resistances, for we suppose it to fall freely. The energy of motion acquired is $\frac{1}{2} \times 5 \times 32 \times 32$, which is 2560; so that, as the law states, the reaction is equal to the action.

Suppose that the same body were allowed to fall not freely, but against a resistance of 60 poundals. When it has fallen $2\frac{1}{2}$ ft. it will have a velocity of 10. In this case the "action"—the work done by the weight of the body—is 160 times $2\frac{1}{2}$, or 400. The work done against the resistances is 60 times $2\frac{1}{2}$, or 150. The increase of energy of motion is $\frac{1}{2} \times 5 \times 10 \times 10$, or 250. Thus the "reaction" is 150 and 250, which is 400.

These examples will give you some idea of the most important interpretation of Newton's third law. The exigencies of space will not permit us here to do more than point out how we account for the apparent loss of energy when imperfectly elastic bodies come into collision. In this case not only is the motion of each body changed, but sundry other effects are produced of which we have said nothing. The bodies are made hotter and are set in vibration. The collision causes a noise, which means that the surrounding air is made to vibrate. Now, all these require work, and the energy that is used in giving rise to these accompanying phenomena, which lie outside the range of our present subject.

X.

Man-like Monkeys (*continued*).—The Gibbons.

We can only briefly allude to the gibbons, which, being smaller than the orang, seem to have retained a wider distribution, occupying forest land not only in the great Malay islands, but also in Hindostan, Further India, and even south China. They are distinguished by having smaller heads and even longer arms proportionally than the orangs. It is possible for some species to lay their hands flat on the ground while in the erect posture; and yet the back has not the curvature of the orang, but is comparatively straight. The chest muscles are enormous, and give great leaping power; some of their swinging jumps, said to extend to twenty-five yards, are really astounding. Not only is the whole arm very long, but the fore-arm is longer in proportion to the upper-arm than in any other large ape. The fingers are most perfect grasping implements, but less perfect in the opposability of thumb to finger than in ourselves. They make much use of their feet for carrying objects about with them in the woods, while their fore-limbs are sufficient for their locomotion. They are so accustomed to an active life and to a warm climate that they usually have but a short existence in captivity, falling victims to consumption.

Long arms.

Interesting internal features of anatomy are the possession of fourteen pairs of ribs, and the smallness of the muscular markings and ridges of the bones of the skull. Their teeth are well adapted for a varying diet, and they feed on all kinds of fruits, leaves, rice, as well as insects and spiders. They can walk and run excellently, and have a special provision for sitting, being furnished with a seat destitute of hairy covering.

Food and habits.

The Siamang, the Lar, the Hoolook, the Agile Gibbon, are the principal species known. The Lar, a native of Tenasserim, is noted for its gregarious habits and its resonant distinct call of "woo-a-woo," which is heard in all tones far and wide in the forest. The young one accompanies the mother, who carries it in safety through her leaping and climbing till able to get about itself. They vary greatly in colour with sex and age. Many gibbons are remarkable for the hood-like long hair of the head, contrasted with the much shorter covering of the face. As a rule all are tractable, intelligent, and amusing in confinement.

Principal species.

Cheek-Pouched Monkeys.

Why do naturalists attach so much importance to this character? Because it happens to be a very evident one,—another instance in which a wide-spread group, numerous in

species, can be distinguished by what is at first sight a mere superficial character.

The greed of monkeys in confinement is proverbial. They seize anything they can lay hands on, and the theft is soon evident by the distention of these cheek-pouches in those which have them. The advantage to the monkeys is obvious, since they easily retain much food in these pouches, and swallow it at leisure, escaping if disturbed by companions, by competitors among monkeys, or enemies of other groups.

Use of pouches.

Pouchless Monkeys.

Pouchless monkeys, if they had nothing to store their extra supplies in, would indeed suffer. But most of those which lack cheek-pouches have huge stomachs, parts of which are available for storage.

There are two main groups of these, bearing the names "Semnopithecus" and "Colobus." They have long tails, and despite this have been very much worshipped in the East, the reason assigned being that they must be beloved of God, having "hands and feet like human creatures." So far from it being thought a degrading thing in India and Further India to have a resemblance to, or to trace a relationship with the animal kingdom, the possession of a resemblance to man was held to elevate the animal.

WEAVER BIRDS. ARGUS PHEASANT. EDIBLE KALONG. ORANG-UTAN.

This, however, does not make it a noble thing in man to worship apes, or to preserve them in countless abundance under the influence of a sacred ban; but when once the idea of fetishism gains possession of a race, only the threat of famines can induce the proper extirpation of a destructive animal. These "sacred apes" were known and first described by Ctesias (400 B.C.), who wrote on the natural history of Persia and India. Gasparo Balbi, in A.D. 1570, a great traveller, Tavernier and others, are among the early discoverers in India; Wallace describes them as full of life and play in Sumatra, being quite careless of the presence of the natives, who do not molest them.

Fetishism.

The black or negro monkeys of Java are of the size of a human infant of a year old, but they have very long tails and jet black hair; they are almost untameable.

Negro monkeys.

The next to be noticed, the nose monkey, or "Kaha," is one of those creatures which must be seen to be appreciated; it lives in Borneo, and puzzles the naturalists by its marvellous nose, and its curious, cunning, depraved features. The skull has no abnormal structure, the face not being very prominent. The nose is extraordinarily long, and bears nostrils on the under surface of the tip when adult; but when still infantile the nostrils are very visible directly in front, and much shorter. The adults are very strong, and as large as a good-sized dog. The compound stomach of these animals has some analogy with the stomach of a pig, but there is no proof of any rumination occurring among them; it is very probable that true digestion, evidenced by the presence of gastric glands, cannot take place in the whole stomach, and that the part nearest the gullet is used merely for storing food.

Nose monkeys.

The Entellus monkey may perhaps be reckoned the most interesting of all. It is very abundant in the tropical plains in the district of the Ganges, the natives both feeding and protecting them. This is the species which in India may approach nearest in size to man; being distinguished by very great length of tail. They are excessively intelligent and impudent in thievery, and by their habits are very capable of occasioning famines; they are powerful and savage in old age, and of course more unlike humanity in features. This may be taken as a general law—that however nearly the monkey may resemble the human

being in features when newly born, the resemblance becomes less and less remarkable with age; also the features by which each kind is distinguished are those which make the face depart furthest from a spherical shape. After the bones of the brain-case grow immovably united by suture, the outer portions continue their growth according to the strength of muscles to be developed, the amount of hair, and the size of teeth. If any similarity in the descent or ancestry of monkeys and man is to be inferred with justice, it would depend far more on the anatomical characters of the infant in each case than on the features originating after birth.

Doucs.

Variegated monkeys, or Doucs, abound in Cochin China, and present very curious varieties of colour, both on the same animal and in the two sexes, and even on the same individual hair. Some have short hair, others red hair in many parts, with other regions pure white. Notwithstanding the nearness of the Douc to the human species in anatomy, there are many distinctions; the face, however, is placed very vertically under the fore part of the brain-case. There are four sharp cusps on the top of the molar teeth, and there is a supplementary lobe on the hinder of them in the lower jaw.

Nestor.

Some of the Ceylon monkeys (Wanderoos) are of small size, and gentle and cleanly in habits, having white beards, and hair for the most part of a dark grey; one has received the name of *Nestor*.

Mode of thieving.

The bear-monkey of Ceylon is more powerful, and has much of the mountaineer and brigand about it. There are others less powerful and more familiar in their ways, with much cunning as well as curiosity. In stealing they adopt something like true military tactics. One monkey is first sent out as a scout; then another passes him, taking stealthy note of surroundings, and so on; till at last, with very little noise, a rush of a score will take place; they secure their wished-for booty, usually from a garden, and quickly clear away.

Small-thumbed monkeys.

The monkeys of Asia differ from those of tropical Africa principally in having very small and somewhat useless thumbs; hence they are named *Colobus*, from a Greek word meaning stunted. Their thumbs have only one little bone, and the special thumb-muscles are rudimentary. They are most active creatures, habitually quadrupedal, and yet tree-climbers. They seem to have almost every structure of the sacred apes of India except this. It must be noted that there are even now about a dozen species of colobi known, and it may very well be expected that more may be discovered in central Africa.

The Semnopithecus has been found fossilised on the Himalayan slopes in the sediment of very old lakes; it is believed that these forms existed long before the Himalayas had been uplifted to their present height. There is no doubt also that members of this family have been found fossil in localities in southern and even central Europe, in rocks of a considerable antiquity even in geological time.

Guenons.

The rest of the apes in central and equatorial Africa, too numerous to particularise, with hind-legs longer than the fore-limbs, and with strong tails, cheek-pouches, and bare buttocks, simple stomachs, and simpler teeth than the last, and with distinct long thumbs, are called the Cercopithecci, or Guenons. These are the commonest among small monkeys, delighting children by their antics, often strangely unsuitable or learnt by a course of punishment. They are at home in trees, and live on fruits and forest food, being highly skilled in hiding. But when in undisturbed possession of the forest each species and group are extraordinarily jealous of intruders, and although they are truly social creatures, personal and age jealousy and competition are apt to occur among themselves.

Fear of a dead snake.

Monkeys have a remarkable fear of snakes, combined with an irresistible attraction. Even a dead snake exerts this influence, as was found by Mr. A. E. Brown, in Philadelphia. A dead snake wrapped up in paper and put into a monkey-house containing forty or fifty of various kinds, was carried off for fun by one of the larger specimens. But when the package became loose and the snake was seen, it was dropped at once; all the monkeys in the house were attracted, and, displaying intolerable fear, formed a circle round the dreadful object. They remained in this position until a string attached to the snake was pulled, when they all fled precipitately with cries and screams; after a time they approached again, and took up similar positions, which they kept for hours. They showed no such fear of a tortoise or a small dead alligator, but played with them quite freely. The dead snake, when shown to the mammals of other groups, was not noticed by them.

GERMAN.

XXXVII.

EXERCISE ON THE PERSONAL PRONOUNS (*continued*).

VOCABULARY.

leihen (imp. lieh, p. part. geliehen), to lend
ly'-en *lee* *ge-lee'-en*

verleihen[1] (imp. verlieh, p. part. verliehen), to
fer-ly'-en *fer-lee* *fer-lee'-en*
vouchsafe, to bestow, accord

das Reich, the empire
dass ryeh

schützen, to protect
shuet'-sen

gewonnen[2] (from gewinnen), won
ge-von'-nen *ge-vin'-nen*

das Vergißmeinnicht,[3] the forget-me-not
dass fer-giss'-mine-nicht'

durchſchießen (imp. durch-ſchoß, past part. durch-ſchoſſen), to shoot through, transfix
doorch-scheess'-en *doorch-shoss* *doorch-shoss'-en*

treffen[4] (imp. traf, p. part. getroffen), to hit (an object in shooting, etc., a mark aimed at)
tref'-fen *trahf* *ge-trof'-fen*

ſich erinnern[5] (Ich erinnere mich, etc.), I remember
sich er-inn'-ern *ich er-inn'ere mich*

froh, glad, cheerful
fro

die Taſſe (Italian *tazza*), the cup
dee tahss'-e

die Wahrheit, the truth
dee vahr'-hite

das Geheimniß,[6] the secret
dass ge-hime'-niss

ſtreiten[7] (imp. Ich ſtritt, p. part. geſtritten), to quarrel
stry'-ten *ich stritt* *ge-stritt'-en*

die Friſt, the term, appointed day
dee frisst

verſtreichen[8] (imp. verſtrich, p. p. verſtrichen), to pass away (sweep by)
fer-stry'-chen *fer-strich'* *fer-strich'-en*

erblaſſen,[9] to die (poetical)
er-blass'-en

der Oheim, the uncle
dare o'-hime

annehmen[10] (imp. Ich nahm an, past part. angenommen), to take the part of any one
an'-nay-men *nahm an* *an'-ge-nom-men*

ſchwierig, difficult, irksome
shveer'-ich

anvertrauen, to entrust
an'-fer-trow-en (*ow* as in *cow*)

der Aufſatz,[11] the essay
dare owf'-zats

vorleſen (imp. ich las vor, p. part. vorgeleſen), to read out, aloud
fore'-lay-zen *ich lahs fore* *fore'-ge-lay'-zen*

die Erfahrung,[12] experience
dee er-fahr'-ung

die Klugheit, cleverness
dee klooch'-hite

die Einwendung, the objection, remonstrance
dee ine'-vend-ung

die Zwietracht,[13] discord
dee tsvee'-traeht

vermeiden (imp. vermied, p. part. vermieden), to avoid
fer-my'-den *fer-meed* *fer-meed'-en*

das Unglück, misfortune, unhappiness
dass un'-gluck

OBSERVATIONS.

[1] *Leihen*, to lend, is literal, and used of outward things; *verleihen*, to impart, is figurative, and used of abstract ideas. Thus—*eine Summe Geldes leihen*, to lend a sum of money; *einen Werth verleihen*, to impart a value.

[2] *Gewonnen*, won, is here a participial adjective from the verb *gewinnen* (imp. *gewann*, past part. *gewonnen*), of which we have a shortened form in the English, to win, won.

[3] *Mein* is here an old form of the genitive *meiner*, of me; *vergiss*, imperative of *vergessen*.

[4] *Treffen* also means "to meet"; *Ich traf meinen Freund in London*, I met my friend, etc.

[5] *Sich erinnern* governs the genitive, and is a reflective verb. The construction is like the French: "Je me souviens de son père," *Ich erinnere mich seines Vaters.*

[6] *Geheimnisz*, from *Heim*, home—a thing kept at home, not published abroad.

[7] Hence the English words to strive, and strife.

[8] *Verstreichen.* The prefix *ver* has here the signification *away; verwehen*, to blow away.

[9] *Erblassen*, literally to turn pale; the prefix *er* often means utterly, or fatally.

[10] *Annehmen*, as a reflective verb with the genitive, signifies to take up the cause or to take the part of any one; with the accusative as a transitive verb it is simply to accept: *Er hat sich meiner angenommen*, he has taken up my cause; *er nahm das Geschenk an*, he accepted the present.

[11] *Der Aufsatz*, the essay; from *aufsetzen*, to set up, or compose.

[12] *Fahren*, to fare; *Erfahrung*, what is learnt as we fare onward.

[13] From *trachten*, to strive or endeavour; and *zwei*, two—to pull in two directions.

English Version for Correcting the above Study, and for Re-translation into German.

Have you already (yet) read this beautiful book? If not (so) I will lend it to you. "To me it was vouchsafed to protect the German empire," said a brave German emperor, after a won battle. Forget-me-not is the name of a little blue flower. "With this second arrow transfixed I you, if I had struck my dear child," said Tell to Gessler. Ferdinand and Isabella of Spain could rejoice (themselves) over that which (thereover that) he and she had done for the country. I spoke yesterday with Herr Müller, but he did not remember me. I could remember him well. We have made (for) ourselves a cheerful day; we can be contented with it. The cup is broken; we cannot drink out of it. She has commanded him to tell her the truth. We cannot explain these secrets to ourselves. Do not quarrel, children; you shall be kind to one another. "If the term has passed by before thou comest back (for me) must thy friend die instead of thee," said Dionysius, the tyrant, to Moros, his prisoner. The girl has a good uncle; he will take up her cause. To him I can entrust this difficult affair, for he considers well what he does. Read (you) us this essay once more; we shall be grateful to you. In many things, experience is just as useful to us as cleverness. I beg you, make not (to me) so many objections. Discord one must avoid; it brings unhappiness to man.

STUDY FOR READING AND PRONUNCIATION, AND TO BE LEARNT BY HEART.

Das Kind des Auswanderers.[1]
dass kind dess owss'-wan-der-ers

THE CHILD OF THE EMIGRANT.

Der Reiſewagen[2] iſt bereit,
dare ry'-ze-vah-gen *ist be-rite'*
The travelling carriage is ready,

Die Pferde ſcharren[3] draußen ſchon,
dee pfairr'-de sharr'-en drowss'-en shone
The horses scrape outside already,

Wie thut's mir doch ſo leid,[4] ſo leid,
vee toots meer doch zo lide zo lide
How doth it me truly so grieve, so grieve,

Zu zieh'n ſo weit, ſo weit davon!
tsoo tseen zo vite zo vite dah-fone'
To travel so far, so far away!

Der Vater, dem es nicht gefällt
dare fah-ter dame ess nicht ge-fellt
The father whom it not pleases
Hier in[5] dem deutschen Vaterland,
here in dame doit'-shen fah'-ter-land
Here in the German fatherland,
Fort will er in[6] die weite Welt,
fort vill airr in dee vy'-te velt
Away will he into the wide world,
In fremde Länder, unbekannt.
in frem'-de lenn'-der un'-be-kannt
Into strange lands unknown.

Wir fahren[7] über's weite Meer,
veer fah'-ren ue'-berss vy'-te mairr
We fare over the wide sea,
Wir fahren nach Amerika,
veer fah'-ren nach ah-may'-ree-kah
We fare to America,
Und kommen nimmer wieder her,
unt kom'-men nim'-mer vee'-der hair
And come never again hither,
Sind heut' zum letzten Male da.
zint hoit tsum letz'-ten mah'-le dah
Are to-day for the last time here.

Leb' wohl, leb' wohl, du liebes Haus,
layp vole layp vole doo lee'-bes house
Farewell, farewell, thou dear house,
Du Garten, Wiese, Wald und Feld!
doo garr'-ten vee'-ze vald unt feld
Thou garden, meadow, wood, and field!
Wir gehen fort, wir wandern aus,
veer gay'-en fort veer vand'-ern owss
We go away, we wander out,
Wir ziehen in die weite Welt.
veer tsee'-en in dee vy'-te velt
We travel into the wide world.

Ihr Kameraden,[8] groß und klein,
eer kame-rah'-den gross unt kline
Ye comrades great and small,
Ich habe euch geliebt so sehr;
ich hah'-be oich ge-leept' zo zayr
I have you loved so much;
Ach, scheiden[9] muß ich ganz allein
aoh shy'-den muss ich gants al-lyne
Ah, part must I quite alone
Und seh' euch nie und nimmermehr!
und zay oich nee unt nim'-mer-mair
And see you never and never more!

Der Vater ruft, die Mutter weint,
dare fah'-ter rooft dee moot'-ter vihnt
The father calls, the mother weeps,
Und alles blickt auf uns so trüb;
unt al'-les blickt owff uns zo trueb
And all looks on us so mournfully;
Die Leute haben's gut gemeint,[10]
dee loi'-te hah'-bens goot ge-mihnt'
The people have it well meant,
Und haben uns noch jetzt so lieb.[11]
unt hah'-ben uns noch yetst zo leep
And have us still now so dear.

Die Peitsche knallt,[12] der Wagen knarrt,
dee pite'-she knallt dare vah'-gen knarrt
The whip cracks, the carriage creaks,
Dort liegt das Dorf im Morgenroth.
dort leecht dass dorf im mor'-gen-rote
There lies the village in the morning red.
Die Leute wünschen gute Fahrt,
dee loi'-te vuen'-shen goot'-e fahrt
The people wish good passage,
Ja, ja, wir ziehen mit Gott, mit Gott,
yah yah veer tsee-en mit gott mit gott
Yes, yes, we go, with God, with God.

REMARKS ON THE DERIVATIONS OF WORDS, ETC., IN THE FOREGOING STUDY.

[1] *Der Auswanderer*, literally the out-wanderer. *Der Einwanderer* is the immigrant.

[2] The word *Wagen*, in German, means any kind of carriage, from a coach to a waggon.

[3] *Scharren* means to scrape or scratch, like a pawing horse or a fowl scratching up the ground.

[4] *Es thut mir leid* is a German idiom, meaning I am sorry, I grieve. Thus in Schiller's Wallenstein, *Es thut mir leid um meine Obersten*, I am sorry for the sake of my colonels.

[5-6] We have here *in* with the dative, signifying locality (where), and *in* with the accusative, signifying direction (whither).

[7] *Fahren* (imp. *fuhr*, past part. *gefahren*) means originally to go or *fare*. Thus, *Fahre wohl* is farewell; like *Lebe wohl*, live well: the latter is more generally used; *der See'-fahrer*, the seafarer or mariner, etc.

[8] The word *Kamerad*, comrade, originally meant a soldier occupying the same chamber or tent with another. Thus we have the term *ein Zeltbruder*, a tent brother.

[9] *Scheiden* (imp. *schied*, past part. *geschieden*), to part or sever. *Unterscheiden*, to distinguish (mentally separate); *der Unterschied*, the difference.

[10] *Es gut meinen*, to mean well, to be favourably disposed. *Er meint es schlecht*, he is badly disposed, or has evil intentions.

[11] *Lieb haben* is an idiomatic expression, meaning to hold in affection. *Er hat das Kind lieb*, he loves the child; *die Kinder haben ihre Eltern lieb*, the children love their parents.

[12] *Der Knall*, in German, means a sharp crack or report, like that of a gun or pistol.

Exercise on the Foregoing Study, for Re-translation into German, to be Corrected by the German Version given below.

It does not please my father here in the German fatherland. We journey over the sea. We go to America. It grieves me to travel so far away, into strange unknown lands. The travelling-carriage is ready. We emigrate (wander out) and travel into the wide world. Farewell thou dear house, and ye gardens, meadows, forests, and fields. We come not back, for we go to America. You comrades all, whom I have loved, I say farewell to you; for now I must depart, and I shall see you no more. All the people look at us with mournful eyes. They have meant (it) well with us. My (the) father cries "Farewell," and my (the) mother weeps, for it grieves her also to part from good friends. And now lies the village behind us in the morning red. For the last time farewell, ye good friends.

German Version.

Es gefällt meinem Vater nicht, hier
ess ge-fellt' my'-nem fah'-ter nicht here
in dem Deutschen Vaterland. Wir
in dame doit'-shen fah'-ter-land veerr
ziehen über das meer. Wir gehen nach
tsee'-en ue'-berr dass mare veerr gay'-en naach
Amerika. Es thut mir leid so weit
ah-may'-ri-kah' ess toot meerr lide zo vite

weg zu reiſen, in fremde unbekannte
vech tsoo ry'-zen in frem'-de un'-be-kann'-te
Länder. Der Reiſewagen iſt bereit.
lend'-err dare ry'-ze-vah'-gen ist be-ryte'
Wir wandern aus, und reiſen in die
veerr van'-derrn ows unt ry'-zen in dee
weite Welt. Lebe wohl, du liebes Haus, und
vy'-te velt lay'-be vole doo lee'-bes house unt
ihr Gärten, Wieſen, Wälder und Felder.
eer gerr'-ten vee'-zen veld'-err unt feld'-err
Wir kommen nicht Zurück, denn wir
veerr kom'-men nicht tsoo-rück denn veerr
gehen nach Amerika. Ihr Kame-
gay'-en nach ah-may'-ree-kah' eerr kah'-me-
raden alle, die ich geliebt habe ich
rah'-den al'-le dee ich ge-leept' hah'-be ich
ſage euch Lebewohl; denn nun muß ich
zaa'-ge oich lay'-be-vole denn noon muss ich
ſcheiden, und ich
shy'-den unt ich
werde euch nicht
vairr'-de oich nicht
mehr ſehen. Alle
mairr zay'-en al'-le
die Leute ſehen
dee loï'-te zay'-en
uns mit trüben
uns mit true'-ben
Augen an. Sie
ow'-gen an zee
haben es gut
hah'-ben ess goot
mit uns gemeint.
mit uns ge-mynt'
Der Vater ruft
dare fah'-terr rooft
„Lebet wohl," und
lay'-bet wole unt
die Mutter weint;
dee moot'-ter vynte
denn es thut ihr
denn ess toot eerr
auch leid, von guten Freunden zu ſcheiden.
ouch lide fon goot'-en froind'-en tsoo shy'-den
Und nun liegt das Dorf hinter uns im
unt noon leegt dass dorf hin'-ter uns im
Morgenroth. Zum letzten Mal lebet
morr'-gen-rote tsum lets'-ten mahl lay'-bet
wohl ihr guten Freunde.
vole eerr goot'-en froin'-de

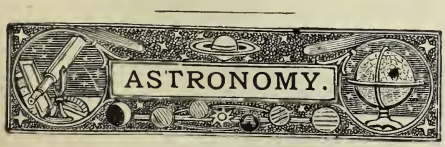
FIG. 91.—TELESCOPIC VIEW OF THE CONJUNCTION OF VENUS AND SATURN, ON DEC. 19, 1845.

within four times the mean distance of the sun from the earth, and so enabling us distinctly to discern on its surface markings less than a thousand miles in diameter. When examined, the disc presented by Jupiter is seen at once to be an ellipse in form, with axes in the proportion of 16 to 15, so that it is obvious that the planet is very spheroidal in form, the ellipticity being about $1 \div 15{\cdot}7$. This considerable ellipticity probably arises from the combined effect of the quick rotation of the planet conjoined with its large diameter. We do not see, however, the actual surface of the solid body of the planet, but only the uppermost of the cloud-bearing strata of its atmosphere. It has been supposed, therefore, by some astronomers that the true surface of the planet may lie very many miles beneath the cloud surface alone visible to us, and be far smaller in dimensions and less elliptical in form. But closer consideration shows that this cannot be the case, for, owing to the large diameter and greater power of gravity, the density of the atmosphere of Jupiter must so rapidly increase with the depth beneath the upper-lying strata of clouds, that at a distance of less than a hundred and fifty miles the atmosphere must be so condensed as to cease to be gaseous. It is true that the dense cloud-belts which we see on Jupiter, and the complex spectrum which is exhibited by the light it reflects to us, lead us to suppose that the temperature of the planet is far greater than the temperature of the earth—that, in fact, the lower-lying strata of the atmosphere and the true surface of the planet may be nearly white-hot, but even under these conditions the depth of the atmosphere of Jupiter cannot much exceed a hundred miles.

Its atmosphere.

When at its mean distance from the earth the equatorial diameter of Jupiter is 37·62″ and its polar diameter 35·16″, though, owing to the effect of irradiation, the apparent telescopic diameter of the planet is some 2″ larger. When in opposition, however, the diameter may rise to as much as 48″, and when at its greatest distance from us fall as low as 32″. It follows, therefore, that the polar diameter of Jupiter is 82,380 miles and the equatorial diameter 88,140 miles, the mean diameter being 86,000 miles or eleven times as great as that of the earth, so that in volume it exceeds the latter by over thirteen hundred times. The mass of Jupiter can be calculated with great certainty from the motion of its satellites, and is $1 \div 1047{\cdot}8$ that of the sun, or

Its dimensions.



XXXVI.

JUPITER.

JUPITER is the largest planet of the solar system, and the one most favourably placed for our study of all the greater planets,—it approaching us at times, when in opposition, to

some 300 times as great as that of the earth. It follows, therefore, that the mean density of the planet is only about one-fourth of that of the earth—a confirmation of the view that the mean temperature of Jupiter is very much the greater of the two, the entire body of the planet being probably still white-hot, and therefore far less dense than it otherwise would be.

Jupiter rotates on an axis inclined very slightly to the plane of its orbit, once in about 9 hours 55½ minutes, the exact period of its rotation being unknown, for it has been definitely ascertained that different objects on its surface rotate in different times, they being probably clouds floating in its atmosphere at different heights and moving with different velocities. Thus certain small white spots have been observed to rotate so quickly that they make a complete rotation once in $9^h\,50^m\,5^s$, whilst a great red spot which has been visible for the last four years required $9^h\,55^m\,34{\cdot}5^s$ for a rotation. Other spots in the belts have in turn rotation-periods differing a little from either.

Its rotation.

When viewed in a telescope, the disc of Jupiter is seen to be crossed by a broad equatorial belt of reddish hue, separated from the greyish polar regions by broad white cloud-belts. Frequently the broad equatorial belt is divided into two or more by narrow zones of white or grey clouds; and similarly at times the white cloud-belts of the temperate region are divided by narrow dark belts, usually yellowish or greyish in tint. The great equatorial belt is at times a very deep red in hue, but is more generally orange-brown in colour. On it are usually to be seen a number of greyish or white spots, whilst at times its whole surface is mottled with lighter hues. Dark grey, almost black spots, have frequently been seen in both the dark and bright belts, and yellow and red spots are not infrequent. All these appearances are very variable in character, and present the multitudinous varieties of form, shape, and mutability which we should expect in a highly disturbed atmosphere.

Its belts.

All that is known of the appearance of the planet points to Jupiter being under very different physical conditions to the group of smaller planets of the solar system, and indicate that it is still an intensely heated, incandescent body, more or less completely veiled from our view by great masses of dense cloud floating in an atmosphere the scene of great whirlwinds, swift currents, and tremendous cyclones. And though probably a planet of older birth than the earth, from its great mass and dimensions it has advanced far slower in its career as a planet, and in physical condition resembles the earth as it was long before the earliest epoch of geology.

Physical condition.

Jupiter has four satellites, which move round it in almost circular orbits situated in nearly the same plane as the equator of the planet, which is inclined at an angle of 3° 5′ to the ecliptic. The satellites are distinguished by being numbered I. to IV. as one proceeds outwards. The mean distances in radii of Jupiter and the period of a complete sidereal revolution are as follows—

Satellites.

				d.	h.	m.	s.
I.	Distance = 6·048	Period =	1	18	27	33
II.	,, = 9·623	,, =	3	13	14	36
III.	,, = 15·350	,, =	7	3	42	33
IV.	,, = 26·998	,, =	16	16	31	50

These satellites usually shine like stars of the sixth magnitude, III. being the brightest and IV. the faintest; yet both III. and IV. are subject to great variations in this respect, sometimes being so faint that they can only be detected with some trouble. In consequence, though these satellites are usually not to be distinguished when in transit across the disc of the planet, owing to the little differences in brightness between the surfaces of the planet and satellite, yet at times they appear as dark spots when in transit. Many astronomers have suspected the existence of dark spots on these satellites, which would account for these variation in brightness.

It has been supposed that these dark transits of the satellites indicate that the central portions of the disc of Jupiter shine very much brighter than the edges; but it has been noticed that the satellite frequently appears dark up to the very moment it reaches the edge of the planet, and shines with much diminished lustre even when seen against the dark sky.

These bodies are all large enough to have sensible discs in a telescope—discs due partly to the real dimensions of the satellites, and partly to irradiation, which augments the apparent diameter of all bright bodies. Their apparent diameters are—

Dimensions of satellites.

I. = 1·10″ II. = 0·95″ III. = 1·60′ IV. = 1·40″

so that their real diameters are about

I. = 0·75″ II. = 0·65′ III. = 1·20″ IV. = 1·10″

and their dimensions in miles are—

I. = 1750 II. = 1500 III. = 2800 IV. = 2550.

The two outer satellites are therefore somewhat larger than the moon, whilst the two inner are somewhat smaller. It is not improbable that these satellites are surrounded by extensive atmospheres, which produce considerable variations in their brightness according to the prevalence of clouds. It is these variations in meteorological conditions which probably give rise to the observation of variations in the visibility and form of the dark spots.

The phenomena presented by these satellites of Jupiter form one of the most interesting features in connection with the Jovian system; their transits across its face, their eclipses in its shadow, and their occultation by its orbit, all being the objects of numerous and important observations, which, when properly discussed, lead to valuable contributions to astronomy. The configuration of the satellites, and the times of the eclipses, occultations and transits of the satellites and their shadows, are given for each day in the "Nautical Almanac," so that these phenomena can, by all those interested in them, be easily observed and the satellites identified.

XXXVII.

Profit and Loss.

By profit and loss is meant not the absolute profit or loss, but the profit and loss in proportion to the cost price. This proportion is generally calculated with reference to £100 as a standard cost price—so that, in fact, we mean gain or loss per cent. on cost price.

Clearly we have the following proportion :—

Cost price : absolute gain or loss on cost price : : £100 : gain or loss on £100.

The "selling price"—*i.e.* the price at which the goods are sold—is, of course, the cost price *plus* the gain if it be sold at a gain, or the cost price *minus* the loss if it be sold at a loss.

Clearly the following proportions are true :—

£100 : £100 + gain on £100 : : cost price : selling price

£100 : £100 − loss on £100 : : cost price : selling price.

Example :—

A man buys 24,000 lb. of sugar at 4*d.* per lb.; the extra cost of warehousing it, distributing it among his various customers, and so on, makes the cost price ½*d.* dearer. What sum of money must he get for the whole amount, so that his gain may be 10 per cent. on the total cost?

$$\text{Original cost} = \frac{24000}{3}s. = 8000s. = £400$$

$$\text{Extra cost} = \frac{24000}{8}d. = £12\ 10s.$$

$$\therefore \text{Total cost} = £412\ 10s.$$

Now, for every £100 of this cost he must gain £10—*i.e.*, he must get £110 for every £100.

Hence £100 : £110 : £412½ : selling price;

$$\therefore \text{selling price} = £\frac{412\frac{1}{2} \times 110}{100} = £453\ 15s.$$

Exercises.

1. Calculate the gain per cent. in buying spirits at £31 5*s.* for 25 gals. and selling the same at £1 6*s.* per gal.

2. *A* buys goods for £332 10*s.*, and sells them to *B* at a profit of 5 per cent. *B* sells them to *C* at a loss of 5 per cent. At what price did *C* get the goods?

Answers.

1. Gain of £4 per cent. 2. *C* pays £374 11*s.* 8*d.*

Simple Interest.

When money is borrowed or lent, something is paid by the borrower for the use of the money. The sum lent is called the *principal*, and the money paid for its use is called *interest*. The amount of interest is proportional to the *sum* lent, and to the *time* for which it is kept. It is therefore necessary to have some standard both of *time* and principal in order to fix the standard of interest, so that we may be able to compare the rates of interest of different sums lent for different periods. The standard of time chosen by universal custom is one year, and the standard of money is £100. When we say that the interest on a given sum is 5 per cent., we mean that for every £100 lent for a year £5 is paid by the borrower. If it was lent for any fraction of a year, the same fraction of £5 would be paid; and if for any number of years the same number of times £5 would be paid.

Again, if only £50 were lent for a year, the interest paid on it would be only £2 10*s.*; or if £300 were lent for a year, the interest on it would be £15.

Compound Interest.—If the interest is paid every year when it becomes due it is called simple interest, and the amount of interest in that case is the same every year; but if the borrower does not pay it at the end of the year, when it becomes due, his debt becomes larger by the amount of the interest he ought to have paid, and during the second year he must pay interest on this larger debt. When the interest is thus added as it becomes due to the original debt, and interest charged in future on this interest, the interest is said to be *compound*. Thus, if a man borrow £1000 at 5 per cent. per annum, and at the end of the first year does not pay the £50 interest due on it, his debt becomes £1050, and he must pay the interest on *this* sum during the second year—*i.e.*, the interest for the 2nd year will be £50 *plus interest on* £50—*i.e.* £52 10*s.* If at the end of the second year he does not pay this £52 10*s.* his debt becomes £1102 10*s.*, and he must pay interest on this sum during the third year.

The principal and interest (whether simple or compound) added together make the *amount*.

In the following rules and examples interest means *simple interest* except where it is expressly stated to be compound.

There are four things to be considered in every question in simple interest—namely (1) the *principal*, (2) the *rate* of interest per cent., (3) the *time* for which the principal is lent, and (4) the total *interest* for that time. Any three of these being given, we can calculate the fourth.

I. *The principal, rate per cent., and time being given, find the interest.*

The interest for 1 year is evidently found from the statement

£100 : given principal : : interest on £100 for 1 year : interest on principal for 1 year;

i.e. £100 : principal : : rate per cent. : interest for a year;

$$\therefore \text{interest for a year} = \frac{\text{principal} \times \text{rate p.c.}}{100}$$

Having from this found the interest for a year, the interest for any number of years is found by multiplying by that number of years.

$$\therefore \text{interest for any no. of years} = \frac{\text{ppal.} \times \text{rate p.c.} \times \text{no. of years}}{100}$$

Hence the rule—To find interest on a given principal for a given number of years at a given rate per cent., multiply the principal by the rate per cent. and the number of years, and divide the product by 100; the quotient is the required interest.

Example (1) :—
Find interest on £1575 for 10 years at 4 per cent.

$$\text{Interest} = \frac{\text{ppal.} \times \text{rate} \times \text{no. of years}}{100}$$

$$= £\frac{1575 \times 4 \times 10}{100} = £630.$$

Example (2) :—
Find interest on £650 for 4 years 3 months at 8 per cent.

$$\text{Interest} = \frac{\text{ppal.} \times \text{rate} \times \text{no. of years}}{100}$$

$$= \frac{£650 \times 8 \times 4\frac{1}{4}}{100} = £221.$$

Example (3) :—
Find interest on £1040 for 15 weeks at $2\frac{1}{3}$ per cent.

15 weeks $= \frac{15}{52}$ of a year,

$$\therefore \text{interest} = \frac{1040 \times 2\frac{1}{3} \times \frac{15}{52}}{100} = £7.$$

N.B.—The number of weeks must be expressed as a fraction of a year—*i.e.*, we must multiply by the number of weeks and divide by 52.

So if the time is given in days, they must be expressed as a fraction of a year—*i.e.*, we must multiply by the number of days and divide by 365.

Example (4) :—
Find the *amount* in the last two examples.
The amount is the principal *plus* the interest.
$\therefore$ in (2) amount $= £650 + 221 = £871$,
and in (3) " $= £1040 + 7 = £1047$.

Example (5) :—
Find interest and amount of £489 13*s.* 4*d.* for $4\frac{1}{2}$ years at $3\frac{1}{3}$ per cent.

$$\text{Interest} = \frac{(£489\ 13s.\ 4d.) \times \frac{10}{9} \times \frac{9}{2}}{100}$$

$$= \frac{£489\ 13s.\ 4d.}{10 \times 2} = £24\ 9s.\ 8d.$$

$\therefore$ amount $= £489\ 13s.\ 4d. + £24\ 9s.\ 8d.$
$= £514\ 3s.$

II. *Given the interest, principal, and time, find rate.*

Dividing the interest by the number of years, we get the interest for 1 year on the given sum. Then by a Rule of Three statement we find the interest for 1 year on £100—*i.e.* the rate per cent.

Example (1) :—
The interest on £69000 for 10 years is £15180: what is the rate?

Interest for 1 year on £69000 $= 15180 \div 10 = £1518.$

Now, £69000 : £100 : : interest for a year on £69000 : int. for a year on £100,
or 69000 : 100 : : 1518 : rate per cent.

$$\therefore \text{rate per cent.} = \frac{1518 \times 100}{69000} = 2\frac{1}{5}.$$

Ans. $2\frac{1}{5}$.

Example (2) :—
If the interest on £1575 amounts in 10 years to £630, what must the rate per cent. be?
Interest for 1 year $= £630 \div 10 = £63.$
£1575 : £100 : : 63 : rate per cent.

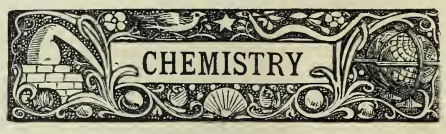
$$\therefore \text{rate per cent.} = \frac{6300}{1575} = 4.$$

Ans. 4.

Example (3) :—
If £500 amount with simple interest for 8 years 3 months to £644 7*s.* 6*d.*, what is the rate per cent.?
Amount in $8\frac{1}{4}$ years $= £644\ 7s.\ 6d.$
Principal $= £500$
$\therefore$ interest in $8\frac{1}{4}$ years $= £144\ 7s.\ 6d.$
$\therefore$ interest for 1 year $= £17\ 10s.$
£500 : £100 : : £17 10*s.* : rate per cent.

$$\therefore \text{rate} = \frac{£17\ 10s. \times 100}{500} = \frac{£17\ 10s.}{5} = £3\ 10s.$$

Ans. $3\frac{1}{2}$ per cent.



XXXV.

Spectrum Analysis (*continued*),

In the preceding article we have given a brief *resumé* of the wonderful process of experiment and induction whereby mankind has arrived at a conclusion with regard to the constituent elements of the sun,—or at least a considerable portion of them, for in addition to those dark lines in the solar spectrum which can be shown to correspond with the bright spectral lines of various terrestrial elements, there are numerous other dark lines for which we cannot account, and which may possibly be due to the existence in the sun of elements differing from those with which we are acquainted. Just as many of the elements common in the world that we inhabit appear to be wanting in the sun, so it is more than probable that the solar orb may contain many elements that have no existence in the earth that we inhabit. Clear as is the evidence in favour of the truth of the theory of spectrum analysis, and irrefragable as are the proofs on which the facts revealed by it are based, we must nevertheless carefully guard against dogmatism; and bearing in mind that the science is still in its infancy, we ought to avoid hasty conclusions and generalization, and patiently await conclusive evidence of the truth of each fresh discovery in this new and illimitable field of research. The existence of oxygen in the sun, for instance, was long doubted; recently the observations of Professor Draper, of America, would seem to show that this element does exist in the sun, but the fact can scarcely, at the time we write, be considered as proven.

Constituent elements of sun.

Lines that cannot be accounted for.

The theory of spectrum analysis based on fact.

Oxygen in the sun.

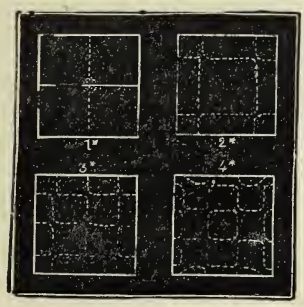
Whatever marvels the future may have in store for the students of this branch of science, sufficient has already been accomplished to strike the mind with a feeling akin to awe, when we come to consider the majesty of the facts revealed and

Results accomplished in spectrum analysis.

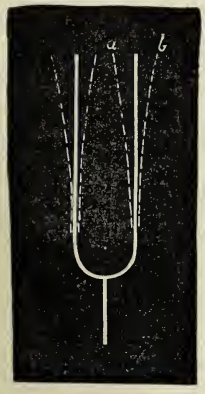
the boldness of the inductions of which the theory is built up. Surely there is something sublime in the idea of a weak mortal taking the sun with him into his laboratory, and pursuing a course of analytical investigation into its component elements across a gulf of more than ninety millions of miles of space!

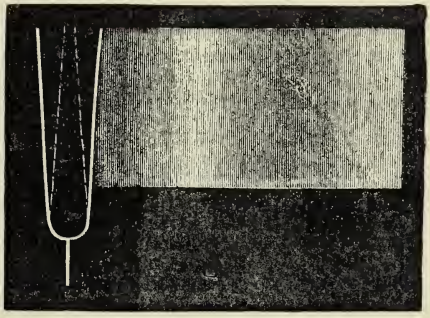
Analytical research across ninety millions of miles.

But we are not satisfied with bringing the sun, so to speak, into scientific subjection. Leaping across the abysmal chasm that separates us from those bright orbs that send their light to us from the infinite depths of space, the mind of man has ventured not to indulge in daring speculation, but to pursue a course of careful and accurate analysis of the material constituents of those remote orbs. Nor is that the only result that has been accomplished: the same investigations that have enabled us to determine the natue of their physical constitution have served to determine the rate of speed at which these different luminaries are travelling through space; for the term 'fixed stars,' so long applied to these bodies, must be for evermore abandoned. None are fixed in the sense of being immovable and motionless points in space. All are travelling through an illimitable region in different directions and at different rates of speed, some singly and some in groups, in obedience to some controlling and guiding principle that binds the whole material universe together.



SOUND FIGURES.




VIBRATIONS OF THE TUNING-FORK ILLUSTRATED.

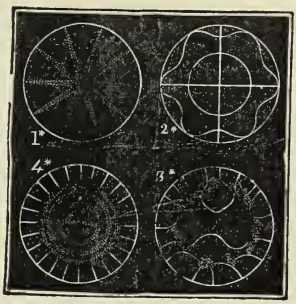
Stellar motions.

We will now endeavour to give our readers some idea of how results so unexpected and astounding have been accomplished. In speaking of light we have already had occasion to comment on the analogy existing between the physical laws of light and sound. Pitch is to sound what colour is to light. A tone is shrill or high-pitched in proportion to the rapidity with which its vibrations reach the ear; while the sense of colour is due to the rate at which the undulations of light reach the optic nerve,—those of the red rays being the slowest, and so on through all the gradations of colour to the blue or violet. It will be seen, therefore, that the highest notes of the octave correspond with the blue end of the spectrum, while the bass notes find their parallel at the red end. As the rate at which sound travels is almost infinitely slow as compared with that of light, it follows that the tone or pitch of a note may be very materially modified by carrying the sounding instrument rapidly away from or towards the ear of the listener. In the one case the waves of sound would reach the ear more rapidly, and in the other more slowly, than if the source of sound were fixed. The sound of a horn has been found to vary materially as the instrument was made to approach or recede from the ear; and it is well known that railway porters and others can distinguish by the tone or pitch of the whistle, even in the darkest night, whether a train is approaching or receding from them. Were the motions of the stars in like manner to increase with the periodicity of the vibrations of light, we might by a parity of reasoning assume that the coour of the stars would vary according to the direction in which they were travelling; those that were moving away from us into the depths of space would appear red, while those that were travelling towards us, and so to speak overtaking the vibrations of light, would assume a blue or violet tone. Doubtless this may be and probably is the case; but the motions even of the heavenly

Analogy of light and sound.

Pitch in sound, and colour in light.

Rate of propagation of vibrations.



SOUND FIGURES.

Sound affected by lengthening or shortening vibrations.

Effect of motion on light.

bodies, infinitely rapid as they are according to our ideas of motion, are as nothing when compared with that of light, and can scarcely be conceived to produce any very marked effect upon the colour of a star. A much nicer method furnished by spectrum analysis has therefore been employed by astronomers to determine the speed and direction of the motions of the stellar orbs. Let us take the example of the bright star Sirius in the constellation Canis. Among the lines in the spectrum of this star have been found those corresponding to the three well-known lines in the spectrum of hydrogen. The slight displacement of these lines in the spectroscope, or rather the displacement of the green line of the hydrogen series—the only one bright enough to be experimented upon—has furnished the well-known astronomer and physicist, Dr. Huggins, with the means of determining, not only the fact that this star is receding from us into space, but also that its rate of speed is upwards of two millions of miles in twenty-four hours. With what a startling picture of the stupendous magnitude of the universe are we here presented! This brilliant orb, the brightest of all the stars, is gradually receding from us at this rate, into the depths of space; and yet its brilliance apparently suffers no diminution, not only from day to day, but from year to year. Many of the nebulæ have in like manner been subjected to this method of research, which has thus furnished the astronomer with a new means of dealing with the sublime problems with which he is presented by the stellar universe.

Method of computing the rate and direction of star movements.

Displacement of hydrogen line.

Dr. Huggins' experiment.

Scale of the universe.

Brightness of Sirius apparently undiminished.

Spectrum analysis and astronomy.

Such are some of the triumphs that have already been accomplished in this new field of science, which doubtless yet enfolds a mine of hidden truth to be discovered by future research. In addition to the wonders it has revealed to us in the orbs of heaven, spectrum analysis has furnished us with a subtle means of detecting the smallest trace of any particular element in a terrestrial compound. Substances existing in quantities so small as to defy detection by ordinary analysis can be readily revealed by this method of research. In this way several new elements have been discovered that have hitherto eluded observation on account of their occurring in very small quantities. Our readers will appreciate the importance of this method of research in cases of suspected poisoning; the chemist being thus enabled to detect the presence of the smallest traces of any foreign substance in the blood and tissues of the body. Fresh instances daily occur illustrating the practical value of this delicate method of analysis, not only as applied to the distant heavenly bodies, but to the commonest substances with which we are familiar in our everyday life.

Spectrum analysis applied to terrestrial compounds.

New elements discovered.

Subtle method of analysis.

It has been truly observed that spectrum analysis has furnished the scientific man with a new sense.

The chemist furnished with a new sense.

Before taking leave of this subject we may add an historical note drawn from Dr. Ure's "Dictionary of Arts," in which it is pointed out that "Dr. Wollaston was the first who observed the existence of non-luminous spaces or dark lines in the solar spectrum. Dr. Ritchie proved that these lines were dependent on absorption, and showed how they could be *increased in visible numbers by artificial means*. Fraunhofer, however, was the first to make a full investigation of them; hence they have been generally called Fraunhofer's lines. The positions the lines occupy have been determined by a careful examination of the map of Fraunhofer, and the very complete delineation of these lines published in the 'Philosophical Transactions' for 1859, by Sir David Brewster and Dr. Gladstone."

An historical note.

With this brief exposition of the principles on which the theory of this novel and deeply interesting branch of knowledge is based, we conclude that portion of our subject which comes under the denomination of Inorganic Chemistry, and shall now proceed to consider those compounds which are known by the term organic. In the eye of the true scientist there is, however, no real distinction, the various so-called organic compounds being, of course, built up of inorganic elements. The various substances that are gradually formed by the process of vital growth—those, in fact, which constitute the bodies of animals and plants—are of course organic; and as the important and widely distributed element carbon enters more or less largely into all these bodies, Organic Chemistry has been justly termed the history of the carbon compounds. The whole of the substances, whether solid or liquid, that form our daily nutriment belong to this class; and the analysis of our food forms, in itself, a highly important branch of organic chemistry. The field of research thus opened is, of course, a boundless one, and our space does not permit us to do more than to touch upon some of the most important and best known of these compounds. The further we advance in this interesting branch of knowledge, the more deeply are we impressed with a sense of wonder at the infinite variety of compounds that the hand of nature has evolved out of a comparatively small number of elements. By slightly varying the proportions in which their constituents are combined, compounds are built up differing entirely in their essential attributes. Two plants growing side by side in the same soil, watered by the same rain or dew, and surrounded by

Conclusion of inorganic chemistry.

Organic chemistry.

History of the carbon compounds.

Food analysis.

Variety of compounds evolved out of few elements.

An illustration from plant life.

the same atmosphere, shall present entirely opposite characteristics : one may be poisonous and the other wholesome ; the fruit of the one may be acrid or pungent, that of the other sweet or insipid. The blossom, leaves—every part of the plant, in fact—may differ in scent, colour, and taste; and yet, when we come to analyse their organic components, we shall find that they vary but slightly in their ultimate chemical constituents.

XI.

Voltaic Electricity.

In our former papers we have endeavoured to place before our readers the facts and principles connected with that kind of electricity which, being produced by the rubbing of two or more substances together, is termed "*Frictional* Electricity." In the present series we intend presenting to our readers a sketch of that equally interesting and even more important branch of our subject which deals with electricity obtained by chemical action, and which, from the names of two of its chief discoverers, is termed Voltaic Electricity, or Galvanism.

About a century ago (namely, in the year 1780), an Italian named Galvani, professor of anatomy at the university of Bologna, was busily engaged in making researches into the effects of electricity upon animals, and in the course of his experiments noticed that the limbs of dead frogs, which had been recently skinned, were convulsed each time sparks were drawn from the prime conductor of an adjacent electrical machine. One day, however, he found that similar convulsions were produced in the legs of a dead frog without the aid of an electrical machine at all. A frog had been skinned and the legs suspended from the horizontal iron bar of a balcony, to which they were attached by a brass or copper wire which passed through the frog's backbone. Every time the wind blew, the frog's toes were blown against the vertical bars of the balcony ; and to Galvani's surprise he found that when this contact of the frog's feet with the metal took place the legs were violently convulsed, in the same way as they would have been had an electric shock been given to them by an electrical machine or a Leyden jar.

Galvani's discovery.

This discovery caused a considerable commotion in the scientific world, and a discussion fierce and long soon arose over its theoretical interpretation ; Galvani and his supporters maintaining that the convulsive movements were due to the flow of a "vital electric fluid" from the spinal cord to the muscles, while others (the chief of whom was Volta, Professor of Natural Philosophy at Pavia), maintained that electricity was produced by the mere contact of the different metals, the frog's muscles only serving as a highly sensitive electroscope.

Galvani's conclusions disputed.

In support of his theory Galvani adduced the further experiment of connecting the frog's spinal cord with the muscles of the legs by a *single* piece of wire, when the same results, though not of so violent a character, were produced. Further, he showed that similar effects might be obtained without any metal at all, by taking the sciatic nerve of a recently killed frog and letting it come in contact with the muscles of the frog's thigh.

Further discoveries.

In this way the contest went on for a considerable time, and from it have arisen results far exceeding in magnitude anything that its principals in their wildest dreams could possibly have imagined. From the simple and apparently trivial discovery that a dead frog's legs may be made to jump, have sprung all those wonderful inventions which culminate in the electric telegraph and the telephone.

As it will be our duty hereafter to show, both these philosophers were partly right in their surmises as to the reason of the phenomena they observed. The existence of animal electricity has been, since Galvani's day, abundantly proved, while the passage of electricity from one metal to another through a conducting medium forms the basis of that science to which we have now to direct our attention.

Modern theory of voltaic electricity.

Volta, in the prosecution of his researches for facts to support his theory, constructed what has since been known as Volta's pile, a representation of which is given in our next diagram.

Volta's pile.

Fig. 38 represents this voltaic pile in its most perfect form. It consisted of alternate discs of zinc and copper, separated from each other by similar pieces of cloth soaked in water acidulated with sulphuric acid, the base of the pile being formed by a zinc plate, its summit by one of copper. The pile was in its finished form mounted, as represented in our diagram, in a frame, a rod running through the centre of the discs. The discs of copper and zinc, with the exception of the terminal ones, were soldered together at their sides, and from each end of the pile a wire passed in such a manner that the two wires might be joined together, or might be attached to any body to which a charge of electricity was required to be given.

When the construction of his pile was completed, Volta found that the effect upon a dead frog was the same as in his first experiments, but much more powerful, while if the two end wires were held in the hand a shock was experienced similar in character to that obtained from a very feebly charged Leyden jar. Further, he found that when the wires were united no such effect could be obtained, but that the temperature of the wires was considerably increased.

Effects of the pile.

These facts ascertained, Volta fancied he saw a complete verification of his contact theory of electricity, and it remained only to connect these facts with those relating to the electricity of an ordinary machine. For this purpose he

Volta's contact theory.

invented and employed the condensing gold-leaf electroscope which we have already described in our lessons on Frictional Electricity. Upon connecting first the zinc and then the copper plate with the collecting plate of the electroscope, the other plate being in each case connected with the earth, he found that while the copper plate exhibited positive electricity, that upon the zinc was negative. In other words, the copper formed the *positive*, the zinc the *negative* pole of the pile.

This experiment appeared to Volta as a certain and unmistakable proof of the correctness of his theory that the metals were of themselves endowed with opposite electricities by the mere fact of their coming in contact with each other,—he regarding the moistened pieces of cloth which alternated between them as furnishing merely a good conducting medium.

Volta's error.

It was, however, in this latter supposition that Volta's error lay. It was soon noticed that the zinc plates of the pile became corroded, and this fact at once drew attention to the acidulated water with which the cloth discs were moistened. Opposition to Volta's theory soon sprang up, and the importance of the acidulated water was at first more than fully recognised, the whole credit being given to it for the production of the facts observed. As we shall, however, see, the truth probably lies between these two extremes; the mere contact of two different metals being sufficient to produce in them opposite electrical *conditions*, but the presence of a body capable of setting up chemical action being also necessary for the production of what we shall hereafter know as an electric *current*.

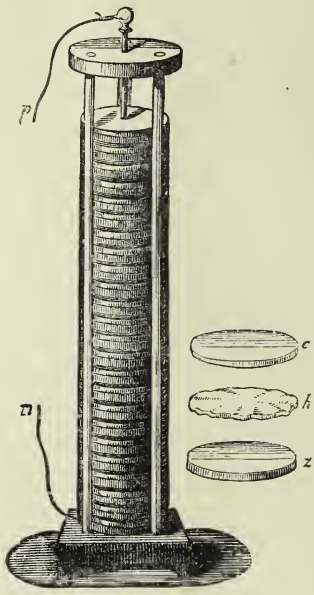


FIG. 37.—VOLTA'S PILE.

The next step in advance was to construct a more convenient source of electricity than the pile, and this took the shape of Volta's so-called "Crown of Cups," the earliest form of galvanic battery.

The Crown of Cups.

A modified form of this is shown in fig. 39. As will be seen, it consisted of a large number of glass cups or jars, each containing acidulated water or brine. A number of strips of zinc, z, were each soldered to similar strips of copper, c, so as to form somewhat U-shaped bars. These bars being reversed, one leg of the U was placed in one jar, and the other in the next jar, in such a manner that each jar contained a strip of zinc and a strip of copper attached respectively to the copper and zinc of the adjacent jars. The terminal strips of zinc and copper were, however, unattached, but instead had strips of copper wire soldered to them—which of course answered to the wires attached to the terminal discs of the pile—while in the same manner the discs were replaced by the united strips of zinc and copper, and the moistened cloth by the acidulated water or brine.

Here then we have the simplest form of voltaic battery, and from it we shall be enabled to trace the various modifications which have from time to time been made in its construction; but it will first be necessary for us to show the nature of the electricity obtained by chemical action, and its connection with that obtained by means with which we are already acquainted.

For this purpose take a simple glass or earthenware jar, as shown in fig. 40. In this jar place a strip of zinc, z, and a strip of copper, c. The zinc must be pure or must be covered with quicksilver, the latter being the better plan, as it is impossible to obtain zinc which is perfectly pure, and if it be not so the acid will act upon it and produce chemical decomposition without current electricity as in the ordinary way, and will therefore vitiate the experiment. As we shall frequently have to speak of amalgamated zinc, it may be as well to at once give the necessary instructions for thus coating the metal with mercury.

How to make a simple cell.

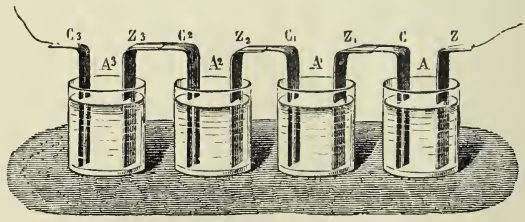


FIG. 38.—THE CROWN OF CUPS.

The process is an extremely simple one. Add a very small quantity of sodium to the mercury (say a hundredth part by weight), and then rub the mercury on the zinc or other metal which it is desired to coat. Or the metal may be amalgamated by simply washing it with hydrochloric acid to clean it, and then rubbing on pure mercury.

Take then such a strip of amalgamated zinc, or a strip of pure zinc and a strip of copper, and place them in the jar. So long as the metals are kept apart, and so long as no liquid is in the jar, no effect whatever will be observed. Now add some dilute sulphuric acid, and still it will

Action of the voltaic cell.

be found that, *as long as the metals do not touch each other*, no change will take place. If, however, the metals be allowed to touch, either inside or outside the liquid, a sensible commotion is immediately set up, and bubbles of gas (which may be shown to be *hydrogen*) collect upon and rise from the copper plate. The same effect may be also produced by connecting the zinc and copper plates outside the liquid by a wire. Let the wire be broken, and immediately the action ceases, while if the two ends be again united the action as immediately recommences.

III.

GERMANY.

THE German Empire is a confederation of German States, established in 1871, under the presidentship of the king of Prussia, who bears the title of Emperor of Germany, and in whose family it is hereditary. The empire comprises the kingdoms of Prussia, Bavaria, Saxony, and Wurtemberg, the grand duchies of Baden, Hesse, Mecklenburg-Schwerin, and others, to the number in all of twenty-six, and is situated between lat. 47° 18′ and 55° 50′ N., and long. 5° 50′ and 22° 50′ E., being bounded on the north by the North Sea, Danish Jutland, and the Baltic, east by Russia, south by Austria and Switzerland, and west by France, Belgium, and Holland. It has a total area of 208,744 English square miles, and a population in 1880 of 45,194,172, of which about 28,000,000 are Protestants, 16,500,000 Roman Catholics, and 600,000 Jews.

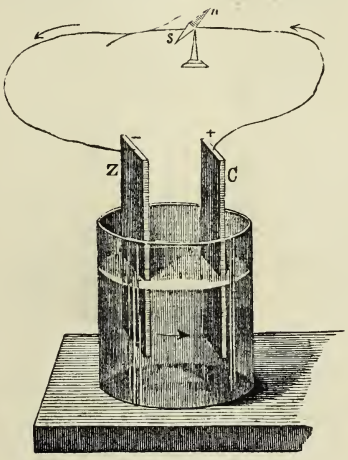


FIG. 46. (*See* p. 328.)

The supreme power is vested in the emperor and the federal council, composed of representatives of the several federal states, to the number in all of 58, of whom 17 represent Prussia, 6 Bavaria, 4 Saxony, 4 Wurtemberg, 3 Baden, 3 Hesse, 2 Mecklenburg-Schwerin, and 1 each of the other states and free towns. In the exercise of certain of the functions of imperial power, the assent of the *Reichstag* or parliament is required, the members of which are directly chosen by the people in the proportion of one representative to about one hundred thousand of the population. The emperor represents the empire in all international affairs, declaring war, concluding treaties of peace, entering into alliances with other nations, receiving and sending forth diplomatic agents, etc. He is commander-in-chief of the army and navy, in peace as well as in war (except the forces of Bavaria and Wurtemberg during peace), and names and dismisses the officers and functionaries of the empire. The first minister of the empire is the chancellor, by whom the imperial edicts require to be signed, and who thus becomes responsible for them. The matters under the direction and control of the emperor and council are chiefly those connected with the army, navy, commerce, navigation, post, telegraphy, railways, justice, finance, education, emigration, colonization, etc. The revenue and expenditure for 1881-2 were each estimated at £29,647,827, the military and naval expenditure being estimated at £16,600,000. The public debt amounts to £17,677,000. The army on the peace footing consists of 294,709 infantry, 64,699 cavalry, 51,166 artillery, and other troops, to the number in all of 427,270 men. On the war footing this force is raised to 1,456,677. The navy comprises 81 ships of war, carrying 538 guns, and having in all 15,099 men.

THE ZOLLVEREIN, or *Customs' Union*, is established for the regulation and control of the customs duties, taxes, commerce, and communications within the empire, though there are certain differences between the limits of the area subject to the Zollverein and those of the empire. Its object is to have one uniform system of taxation and trade regulation over the whole territory in place of several, and its affairs are directed by a committee of the federal council. The total value of the imports in 1879 was £194,640,000, of the exports £141,075,000. The amount of duty collected on articles of consumption imported was £9,111,500. The number of vessels that entered the various ports in 1880 was 51,837, tonnage 7,361,723; that left 51,791, tonnage 7,401,225. The mercantile marine numbered 4,777 vessels, and 1,171,286 tons, of which 374 vessels and 196,343 tons were steamers. The number of emigrants in 1880 was more than three times that of any previous year, being 106,190, of whom 103,115 went to the United States of America. The total length of the railways was 21,200 miles.

PRUSSIA.—The kingdom of Prussia comprises two-thirds of the entire area of the empire (134,470 square miles), and considerably more than half of the population (27,251,067). The war with Austria in 1866 added to its territory Schleswig-Holstein, Hanover, Nassau, Hesse Cassel, etc., having in all an area of 24,500 square miles, and a present population of 4,795,800. It is situated between 49° 7′ and

GREAT BRITAIN AND IRELAND.

55° 50′ N., and long. 5° 50′ and 22° 50′ E., and is bounded on the north by the Baltic, Jutland, and the North Sea, west by Holland and Belgium, south by Lorraine, Hesse, Bavaria, Saxony, and Austria, and east by Russia.

The greater part of Prussia belongs to the great plain of Europe, and is therefore generally flat, with few elevations of considerable size. Along the shore of the Baltic the coast is low and sandy, and here several large lagoons or *haffs* occur. The land rises gradually towards the south, where on the south-east frontier the Riesengebirge or Giant Mountains rise to the height of 5248 feet. The Hartz mountains, in the south-west of the province of Saxony, rise to 3230 feet. The rivers are numerous and important, the principal being the Rhine, Elbe, Oder, Vistula, Niemen, and Pregel. The climate of Prussia varies considerably in different parts. In the north, along the Baltic, it is usually cold and humid, particularly towards the east, where the winters are long and severe. In the central and southern parts the climate resembles that of England, except that the heat of summer and the cold of winter are considerably greater. The great mining districts are Rhenish Prussia, Westphalia, Saxony, and Silesia. Here are found coal, iron, zinc, tin, copper, antimony, etc.

The soil is generally good, and in some parts of great fertility, but there are also extensive tracts of heath, moor, and loose sand. Agriculture forms the principal pursuit of the people, and is generally conducted with great care. The principal crops are rye, oats, and potatoes, and in addition to these wheat, barley, peas and beans, beetroot, flax, hemp, and tobacco, are extensively cultivated. Forests still occupy large tracts of the country. The vine is largely cultivated in the Rhine territory. Prussia has recently made great progress in various branches of manufacture. In Saxony, Silesia, and Rhenish Prussia, linen, woollen, cotton and silk goods, are largely manufactured. A great number of persons are employed in working the metals, and Berlin is particularly celebrated for its cast-iron articles. The other manufactures include leather, paper, tobacco, sugar from beetroot, beer, spirits, etc. Prussia possesses numerous navigable rivers, many of which are connected by canals. The roads are in general excellent, and there are 8000 miles of railway communication. The principal ports are on the Baltic, as Königsberg, Dantzic, Stettin, Stralsund, Memel, and Kiel. On the Elbe, near Hamburg, is Altona. A great part of the trade is carried on overland with Russia and the other adjoining states. The principal exports are the productions of the soil and the manufactures of the country; the imports are sugar, coffee, tea, spices, cotton, silk, dye stuffs, etc.

Prussia is divided into twelve provinces—namely, East and West Prussia, Brandenburg, Pomerania, Posen, and Silesia, in the east; Saxony, in the centre; and Schleswig-Holstein, Hanover, Westphalia, Rhenish Prussia, and Hesse-Nassau, in the west. The capital of the kingdom and of the empire is Berlin, which is in point of size the third city of Europe, having a population of 1,122,360.

The crown of Prussia is hereditary in the male line, and the king is assisted by a council of state. The country is represented in the government by two chambers—that of peers, and that of deputies. The former is composed of hereditary representatives of the higher orders of nobility, of life-members nominated by the king, and of representatives of certain corporations and associations. The chamber of deputies is composed of 433 members, who are elected by the people. About 64·6 per cent. of the population are Protestants, chiefly Calvinists, 33·5 per cent. Roman Catholics, and 1·3 per cent. Jews. The system of national education is regarded as the most perfectly organized system in the world. School attendance is compulsory between the ages of five and fifteen, and there are numerous schools of different grades, from the elementary up to the universities—of which there are ten, the most distinguished being those of Berlin, Halle, and Bonn. The Prussian army on the peace footing numbers 14,004 officers and 330,629 men, thus constituting more than three-fourths of the military strength of the empire. Military service is compulsory on all males on reaching the age of twenty-one. The revenue and expenditure for 1881 are each estimated at £45,653,520, and the public debt amounts to £99,765,649.

BAVARIA, the second in size of the states composing the German empire, has an area of 29,300 square miles, and a population of 5,271,516. It consists of two distinct portions, of which the eastern comprises about eleven-twelfths of the whole, and is bounded east and south by Austria, west by Wurtemberg and Baden, and north by Prussia and other German states. The western portion, called the Palatinate or Rhenish Bavaria, is situated on the left bank of the Rhine. In the south ridges of the Alps penetrate the country and rise to the height of 9000 or 10,000 feet; on the east, between Bohemia and Bavaria, is the Böhmerwald range, rising to the height of 4500 feet; and in the north are the Fichtelgebirge. There are also numerous elevations scattered over the country, but none of them rise to more than 3500 feet. The country in the south is drained by the Danube, flowing eastward; in the north by the Main, flowing west to join the Rhine. The plains and valleys are of great fertility, and agriculture is actively carried on. The forests are extensive, covering about a third of the entire area. About 41 per cent. of the surface is cultivated, producing abundant crops of wheat, rye, oats, barley, and in some districts maize and rice. Among the other products are potatoes, fruit, tobacco, hemp, flax, hops, and, in favourable situations, grapes. Cattle rearing is also carried on to a great extent. The chief minerals are coal, iron, salt, copper, manganese, quicksilver, marble, alabaster, gypsum, graphite, lithographic stone, and porcelain clay. The manufactures are linen, woollen and cotton stuffs, paper, leather, beetroot sugar, hardware, wooden wares, porcelain, glass, etc. One of the most important and extensive manufactures is that of beer, for

which Bavaria is famous. The chief imports are sugar, coffee, tobacco, raw cotton and cotton goods, silks, linen, hemp, flax, iron and iron wares; the exports, timber, grain, wine, hops, beer, leather, glass, jewellery, etc.

The government is an hereditary monarchy, with two chambers, one of lords, the other of deputies. The latter consists of 156 members elected by the people. The army consists of 2214 officers and 50,224 men, and in peace is under the command of the king, but during war is incorporated in the German army under the emperor. The revenue and expenditure are each estimated at £11,087,072, and the public debt is £66,833,133. Of the population about 71 per cent. are Roman Catholics and 27 per cent. Protestants, besides which there are about 52,000 Jews. There are three universities—Munich, Erlangen, and Würzburg. The capital is Munich, which has 230,023 inhabitants.

SAXONY, the third in importance and population of the German states, has an area of 5800 square miles, and 2,972,805 inhabitants, of whom 2,876,138 are Protestants, 72,946 Roman Catholics, and 6516 Jews. The country is separated from Bohemia on the south by the Erzgebirge range, from which it extends northward to Prussia. The southern portion is mountainous, while in the north the land is generally level. The principal river is the Elbe, which enters the country from Bohemia through a district known as "Saxon Switzerland," and flows in a north-westerly direction. About a fourth of the surface is covered with timber, and more than a half is cultivated, producing wheat, barley, rye, oats, and other grain; potatoes, hops, flax, and in favourable situations grapes. The horses and cattle are numerous, and the sheep are celebrated for their wool. The mineral wealth is very great, including iron, coal, silver, lead, tin, zinc, bismuth, cobalt, nickel, arsenic, etc., besides marble, porcelain clay, and precious stones. The manufactures are actively carried on, and include linen, cotton, and woollen stuffs, silks, mixed goods, leather, paper, beer, spirits, pottery, and fine porcelain, known as "Dresden china."

The government is an hereditary monarchy, with two chambers, an upper and a lower, the latter consisting of 80 representatives chosen by the people. The army is comprised of 1137 officers and 27,606 men. The revenue and expenditure are each estimated at £3,187,479; and the public debt is £33,479,171. The capital, Dresden, has 220,818 inhabitants; and Leipsic, which is the seat of a famous university and a noted book fair, 149,081.

WÜRTEMBERG is situated in South Germany, and has an area of 7500 square miles and a population of 1,971,255, of whom 69 per cent. are Protestants and 29 per cent. Roman Catholics. The country is hilly, and is well watered, the principal rivers being the Danube and the Neckar. It possesses well cultivated fields, orchards, gardens, and hills covered with vines. Wheat, oats, barley, rye, potatoes, hops, hemp, and maize, are the principal crops. The minerals consist chiefly of iron, salt, limestone, ironstone, granite. The manufactures are considerable, and the government, like that of Saxony, is an hereditary monarchy, with two chambers. The capital, Stuttgart, has 117,303 inhabitants.

The other members of the German empire do not call for particular notice. They (with their several populations) are:—The grand duchies of Baden, 1,570,189; Hesse, 936,944; Mecklenburg-Schwerin, 576,827; Saxe-Weimar, 309,503; Mecklenburg-Strelitz, 100,269; Oldenburg, 337,454; the duchies of Brunswick, 349,429; Saxe-Meiningen, 207,147; Saxe-Altenburg, 155,062; Saxe-Coburg-Gotha, 194,479; Anhalt, 232,747; the principalities of Schwartzburg-Rudolstadt, 80,149; Schwartzburg-Sondershausen, 71,083; Waldeck, 56,548; Reuss (older line), 50,782; Reuss (younger line), 101,265; Schaumburg-Lippe, 35,332; Lippe, 120,216; the free towns of Lubeck, 63,571; Bremen, 156,229; Hamburg, 454,041; and the territory of Alsace-Lorraine, 1,571,971.

XXXVII.

CHARLES I. (*continued*).

IT was soon after the prorogation of the parliament mentioned in the close of our last article (*see* p. 302), in June 1628, that the murder of Buckingham occurred. Lord Lindsey was sent to conduct the war in France, and made a languid attempt at relieving Rochelle, which was unsuccessful. The king again raised money without consent of parliament, by means of tonnage and poundage, customs duties on goods, and quartered troops on private houses, in direct violation of the Petition of Right; consequently, when in January, 1629, the houses again met, the commons were determined to vindicate the liberties of the nation in no half-hearted way. Laud and Neile, two of the bishops, had moreover preached passive obedience in its most extended sense from their pulpits—declaring that the king was above all laws, and might make new ones or cancel and abolish old ones at his pleasure, and that he had, moreover, full authority over all the property of his subjects. The feeling of parliament on the subject is sufficiently shown by the protestations prepared by Sir John Eliot, at the desire of the commons, which set forth that "whoever should bring in innovations of religion, popery or Arminianism, or any that should advise the taking of tonnage and poundage not granted by parliament, or whoever should pay the same, should be accounted enemies of the kingdom and commonwealth." So now the question that had so long agitated the minds of the English nation was narrowed down to a definite issue. Was the king of England bound to maintain the liberties of the people, and to rule according to

Tonnage and poundage.

Preaching of passive obedience.

the laws as set forth in various acts of parliament and in the common law of England? or were the liberties of the English to be considered as gifts of the king, to be curtailed or abolished at pleasure by a monarch who, according to the doctrine of divine right, was responsible to no man for his actions, but might by his own authority take back what his various ancestors, in the course of centuries, had given?

ARCHBISHOP LAUD.

What the king's own sentiments were on this momentous subject was not suffered to remain in doubt. When, on the 2nd of March, 1629, the Remonstrance was to be read in the house of commons, the speaker, Finch, declared that he had received the royal command to put no such question to the vote, but to adjourn the house. Then the spirit of the house was at last fairly roused. The speaker was forcibly held down in his chair by Hollis and Valentine, two of the most prominent members, while the Remonstrance was read; the door of the house being locked, and the key laid on the table, though Black Rod was knocking for admittance; and when at length let in, after the resolution had been triumphantly carried, removed the mace from the table. Among the men destined to play a great part in the events that arose out of this matter, two especially were present on this occasion—John Hampden, member for Wendover, and Oliver Cromwell, who sat for the borough of Huntingdon.

The Remonstrance in the Commons.

The king immediately dissolved this his third parliament; and the most active of the members, Hollis, Valentine, and Eliot being among them, were committed to prison. Three years afterwards, Sir John Eliot, against whom the wrath of Charles had been especially excited, died in the Tower; the efforts made on his behalf being unable to procure any alleviation of the strict confinement under which his health but not his spirit gradually gave way; and the petition of his sons that his earthly remains might be buried among the ashes of his ancestors was peremptorily refused by the king, who had unlawfully imprisoned him, in direct defiance of the old statute by which the words and deeds of subjects sitting as members of parliament were declared to be privileged.

The third parliament dissolved. Sir J. Eliot.

JOHN HAMPDEN.

For the next eleven years, a dark and shameful period in the annals of England, the kingdom was governed as an absolute monarchy. The court was triumphant, and the followers of the king vied with each other in slavish submission and in extravagant upholding of the royal prerogative. "No statute derogatory of a prerogative, can bind a king," said one of the upholders of royal despotism. "The power of raising money," the attorney-general publicly declared, "is innate in the person of an absolute king. For the king of England, he is an absolute monarch; nothing can be given to an absolute monarch but what is inherent in his person." "The king hath nothing to do with a consent of parliament," said one of the judges, "but he useth law as a servant to rule by, not as a master to restrain him." Another, named Crawley, openly declared that the imposition of taxes without parliament appertained to the king originally. And Charles, ruling without a prime minister, carried out these notions of government among a people whose ancestors had won from their rulers the Great Charter, that had been thirty times confirmed, while he himself had set his hand to the Petition of Right.

1629-1640—Rule without a Parliament.

The means adopted for the support of absolute rule during this period were such as had never been known in England since the days of John. The people were grievously taxed at the sole will and discretion of the king. Monopolies were revived. The ordinary justice of the kingdom was overridden by the decrees of the Star

Chamber and the Court of High Commission, tribunals that inflicted ruinous fines, imprisonment and mutilation, with a reckless cruelty which excited universal horror and disgust. The puritans were especially the objects of the malignity of these infamous courts; for the object of the dominant party was to enforce passive obedience and uniform servility in religious as in political matters. Therefore nonconformity was punished as one of the worst of crimes, and the branding-iron, the whip, and the hangman's knife and shears, were ruthlessly employed to reduce men to submission. For having published a book against stage plays and players, in which the court affected to find passages insulting to the queen, Henrietta Maria, Prynne, a puritan barrister, was sentenced to pay a fine of £5,000, to stand in the pillory at Cheapside and Westminster, to have his ears cut off by the common hangman, to be degraded from the bar, and imprisoned for life. Bastwick and Burton, two prominent puritans, and various others, were visited with similar atrocious penalties, and became martyrs in the eyes of their co-religionists, who honoured them for their sufferings in the good cause.

Prosecution of nonconformists; Prynne.

Though the king had no prime minister, two men had a paramount influence on his policy in this period of arbitrary rule—Laud and Strafford. Laud, an honest and conscientious, but deplorably bigoted and narrow-minded man, considered he was doing the king good service by furthering with a busy and indiscreet zeal the conversion of the English church service to an imitation of the Romish mass, with gorgeous vestments and florid ceremonial. A "Book of Sports" was moreover published under the royal sanction; and games and amusements, chiefly of the athletic kind, were appointed to be held on the village greens on the Sunday afternoons, to the horror of the puritans and the bewilderment of the majority of the country folk, who stared at the innovation. By such means Laud hoped to bring the puritans into contempt and to assimilate all parties in the church to his own model. The other adviser of the king was a man of a very different type. Thomas Wentworth had been a prominent leader of the opposition in the parliament of 1626, a friend of Pym, Hollis, and Hampden; but he had been gained over with other leaders by Charles, and became the most strenuous upholder of the arbitrary principles he had once been imprisoned for denouncing. He was created Earl of Strafford and Viceroy of Ireland, and exhibited in his office the contempt for law and the devotion to arbitrary measures which he consistently advocated for the government of England. His scheme was simple and complete. The king was to raise taxes by his own authority; with a portion of the money thus obtained he was to maintain a standing army; with this standing army he was to put down any attempt at resistance that might be made by a people indignant at the loss of their liberties. Such was the plan of the government designated by its projector by the name of "Thorough"; and it was tried by his master with lamentable consequences.

Archbishop Laud; ecclesiastical tyranny.

Thomas Wentworth, Earl of Strafford.

Strafford's "Thorough."

Want of funds had compelled Charles somewhat abruptly to give up both the Spanish and the French wars. The legal ingenuity of Noy, the attorney-general, another recruit won from the parliamentary side, suggested a ready means of filling the royal coffers. It had been customary in times of war to levy contributions on the Cinque Ports and other maritime towns, under the name of ship money, for the equipment of vessels to be sent against the enemy. This custom the king, at the advice of Noy, not only revived, but extended far beyond its former limits; for instead of collecting ship money from the seaports in time of war, he levied it through the length and breadth of the land at a period of profound peace, taxing the inland counties equally with the coast towns, when it was notorious that no ships were required. Then it was that John Hampden stood forth as the champion of his country's liberties. He boldly refused to pay the illegal impost; and when his native county of Buckingham was assessed at four thousand five hundred pounds, brought the matter to a solemn hearing by defending his refusal in the Court of Exchequer. The verdict was given against him by a majority of the judges, as was to be expected; for under Charles the judges held their offices not "during good behaviour" or permanently, but "during the king's pleasure," and could therefore be removed at the monarch's will; but even then four out of the twelve were for Hampden, and a fifth was doubtful; and as Clarendon, the historian of "The Great Rebellion," observes, "the judgment proved of more advantage and credit to the gentleman condemned than to the king's service." The nation at least knew definitely on what ground it stood; for this decision placed the property of every subject at the king's disposal, and resistance to ship money was generally determined upon.

Ship money; its origin.

John Hampden's trial in the Exchequer Court.

While profound discontent prevailed from end to end of England, Charles very imprudently took the surest means to embroil himself with his subjects in the north. It was resolved to introduce the Liturgy, or form of service according to the Prayer Book, into the Church of Scotland; and on the 23rd of July, 1637, the attempt was made to read the liturgy, for the first time, in the cathedral church of St. Giles, Edinburgh. Clarendon tells us how "a shower of sticks, stones, and cudgels was thrown at the dean's head," so soon as that dignitary began to read the service; and how, with great difficulty, the noisiest of the rioters were turned out of the church and the doors shut by the magistrates and provost of the city, at the demand of the bishop, and the service concluded after a fashion, while the enraged crowd outside were breaking the windows and roaring out threats to break down the doors. The

The Liturgy in Scotland.

presbyterian Scots looked with abhorrence upon church government by bishops, and upon a service that in their estimation savoured of the Romish mass; and in March 1638 was signed eagerly, by a great number of men of all ranks and conditions, the great protest known as the Solemn League and Covenant.

The League and Covenant.

At first the king undervalued the importance of the movement in Scotland; but when discontent swelled into riot and riot into open insurrection, he was compelled to take action, and marched his army to the north in 1639. But the campaign was feebly conducted, Charles being probably surprised and bewildered at the extent of the resistance his measures had provoked. A treaty was agreed upon, known as the Pacification of Dunse. A Scottish parliament was to assemble for the adjustment of differences; but that parliament made demands the king would not grant, and refused to dissolve at the summons of the king's commissioners, or to disband its army. The war was to be renewed, and the king's exchequer was empty.

Campaign against the Scots.

Under these circumstances, after an interval of eleven years, an English parliament, afterwards significantly known as the Short Parliament, was summoned to meet at Westminster. It assembled in March 1640; and Pym, Hollis, Hampden, Oliver St. John, who had defended Hampden in the ship-money case, and other prominent leaders of the popular party, once more appeared in the house of commons. The members are acknowledged, even by the partizan Clarendon, to have been loyal and respectful, and "exceedingly disposed to please the king and to do him service." But the house showed a disposition to inquire into grievances, and to demand their redress, while ready to vote money liberally for the king's necessities; and suddenly Charles came down to the house of lords and dissolved the new parliament, that had only sat for three weeks.

The Short Parliament.

Clarendon's opinion.

As on the dismissal of the former parliament, so now again, several of the chief members of the opposition were committed to prison. Another forced loan was raised, and ship money was again exacted. The popular indignation now took the form of riots in London and various other towns. Laud's palace was attacked, and a mob broke into St. Paul's, where the High Commission Court was sitting, with seditious cries of "No Bishop! no High Commission!" The patience of the nation was manifestly near its end.

Meanwhile the king once more marched his army to the north; for the Scots had crossed the border, and were coming southward in force "to petition the king." But at Newburn his troops ran ignominiously from the foe. Nothing now remained but to patch up a hasty truce with the insurgents; and as the game of absolute government had ignominiously failed, to appeal once more to a parliament; which was summoned towards the close of the year.

Defeat at Newburn.

XXXVII.

Exercises (continued from p. 295).

Translate into English:—

Exercitus Gallorum fortissimis habebatur. In rebus dubiis appare amicus, in rebus necessariis justus et recti tenacissimus. Mores ejus delectissimi in civitate corruptissima usque ad finem integri manebant. Virgilius et Horatius summi poetæ nati sunt, non facti sunt. Nemo sine virtute recte justus dicitur. Omnes nascuntur nudi, neque rerum præsentiarum conscii. Oratores nostri audiunt esse male otiosi. Multâ diligentiâ puer evasit doctissimus. Argentum efficitur clarum attritu. Bonus vir patientia redditur melior, non pejor. Si tu utaris tempore tuo, evades vir ad hanc civitatem clarissimè utilis. Nunquam desine esse fidelis ad amicos, et fortis esse ad inimicos. Quando demum tua ambitio effrænata audax et nocens reipublicæ esse desinet?

Translate into Latin:—

Cicero, the consul, was hailed by all Roman citizens, except the associates of Catiline, as the worthy saviour of his country, and such he used often to call himself. The walls of the city remained entire even after the many attacks of the enemy. Pleasure is not the highest good of the human race, either in this life or in the life to come. Expediency (*utilitas*) is the mother of invention. Pain is at times (*aliquando*) a very great blessing (*bonum*). This city is called Rome, and that Gabii.

The Syntax of the Genitive Case.

The Genitive after the Substantive.

I. When two substantives come together, the latter is put in the genitive case—as *corona regis*, the crown of the king. Here *regis* is the genitive (of *rex*) because it is the latter of the two substantives of which *corona* is the former. The genitive case generally marks the dependence of one substantive on another.

II. The genitive denotes the possessor, or the person or thing whereto anything belongs, as in *Cæsaris exercitus*, the army of Cæsar; *Platonis philosophia*, the philosophy of Plato.

III. The possessive genitive marks *duty*, or the *characteristic* of the person or thing in the genitive, as in *boni est civis civibus benefacere*, it is the part or duty or mark of a good citizen to do good to his fellow-citizens. Here *civis boni* are in the genitive case, because it here marks the duty which is supposed to belong to the *bonus civis* as such. The idea is really best accounted for by the supposition that the genitive case is dependent on a word understood, and is therefore, according to our general rule, the *latter* of two substantives put in the genitive—as *officium*, understood for *duty*, *proprium munus*, for characteristic or mark, which is sometimes expressed, as in *Senatûs* OFFICIUM *est civitatem consilio juvare*, it is the duty of the senate to help the state by its advice.

IV. The genitive case after the substantive denotes a *whole* of which *a part* is taken, and accordingly is called the *partitive* genitive, as in *modius tritici*, a peck of wheat. Here *tritici*, the genitive, marks the *whole quantity* (of wheat), of which a part (*modius*, a peck) is taken.

V. The genitive case after the substantive denotes *quality, character, description*, as in *vir maximi corporis, et minimæ mentis*, a man of the largest body and of the smallest mind. Here the genitives mark *quality, character*, and *description*. So *homo magni ingenii*, a man of great ability.

VOCABULARY (of words not before given, to be learnt off) :—

Causâ, gratiâ, ergo, for the sake of, or on account of; *instar*, the size of, or like to; *simulatio*, a pretence; *triticum*, wheat; *juger* (neut.), an acre; *fossa*, a ditch; *quivis*, any one you like; *ingenuus*, ingenuous; *uterque*, each one; *conjecturam facere*, to form a conjecture; *levis*, frivolous; *protegere*, to shield; *prospicere summæ rerum*, to look to the main point; *jussa capessere*, to execute orders; *consulere* (with an acc.), to consult; *consulere* (with dative), to consult for the interest of; *cedere*, to yield to.

Exercises.

Translate into English :—

Vir summæ virtutis. Simulatio amicitiæ. Dolores suscipiuntur majorum dolorum effugiendorum gratiâ. Fossa quindecim pedum, puer decem annorum. Cujusvis hominis est errare. Homini soli animalium dolor mentis est datus. Ingenui vultus, ingenuique pudoris. Virtutis est periculum contemnere propter honorem et pro patriâ. Uterque nostrûm hoc præstare cupit. Consul vir erat magnæ virtutis et notæ constantiæ. Stultorum est semper ridere, nunquam sapienter agere. Artis est summæ omnem artem colere. Pecus est Melibæi, adolescentis et cujusvis majores natu revereri. Hæc vestis est patris, illa autem matris. Multa pars tui patris fiet. Nunquam imperatoris est boni suos milites deserere. Quid caput regnorum est majus quàm Roma? Testis est veri verum dicere, nec quid mentiri. Servorum est fidelium servare dominorum bona in tuto absentium neque secreta familiæ in lucem tradere.

Translate back into Latin the following passages from Latin authors :—

It is [a token] of a good judge to form a conjecture from the least things. It is [a token] of levity to exult in prosperity. It is [a mark] of a fool to be agitated by frivolous matters. To warn and be warned is [a function] of true friendship. My departure is [a sign] of my despair, not of my embassage. It is [a function] of your magistracy to shield citizens from wrong. It is [a mark] of an impudent man to abuse the patience of the judges. It is [a part] of [our] duty to help the poor, not the rich. It is [the part] of a commander-in-chief to look to the main point: of a lieutenant to execute orders. It is [the nature] of a great mind to despise wealth. It is [the nature] of young men to yield to pleasures: of old men, [to yield] to avarice. It is [the part] of a good general to consult the health of [his] troops; to beware-of ambush; to keep [his] reserves ready for the battle; to aid with reinforcements [his] soldiers [when] distressed. Sulla surrounded his camp with a ditch of fourteen feet. Titus Manlius, a man of severe austerity, then addressed his soldiers. Pericles was not only an orator of much skill, but a soldier of true valour. The emperor Titus was a man of consummate ability and of the greatest good nature and prudence. Fabius was considered to be a man of great influence in the elections. It is not the part of wisdom to neglect any portion of human or divine knowledge. It is the duty of a general to save his troops from slaughter which is unnecessary.

FIG. 195.—MANDRAKE.

Self-Examination Questions.

How do you account for the genitive case after a noun as a general rule? When does the genitive mark *possession, duty, property, quality, character*, or the whole of an object? Give examples of each of these usages, and account for them. Learn by heart and write out the vocabulary, and construct sentences exemplifying the rules and usages given.

BOTANY.

XXXVII.

VARIOUS ORDERS (*continued*).

WE here continue the consideration of the Solanaceæ (*see* p. 309), and shall first of all speak of the venomous species. The true Deadly Nightshade is a bushy, somewhat succu-

lent, herbaceous plant, growing usually to the height of about a yard. The leaves are ovate ; and, singular to say, alongside every large or principal leaf there is a smaller one of the same form. By this one simple mark it is possible at almost any time to identify this terrible plant. The flowers come out singly from the axils of the leaves. They are just the shape and size of a little girl's thimble, of a dull brownish-red, and half-pendulous. In due time they are followed by shining black berries, not unlike black-heart cherries. The flavour of these berries is sweetish, but to swallow three or four of them is death. We have been thus particular in describing the famous belladonna, because another of the Solanaceæ is very generally mistaken for it. This latter is the *Solanum Dulcamara*, or bittersweet nightshade. The plant is an untidy scrambling one, very often an inhabitant of hedges, and of the bushy tangle round ponds. The leaves are partly ovate, partly with two large lobes at the base. The flowers are in figure star-shaped, nearly half an inch across, and produced in clusters of six to twelve. Being of a rich violet-purple, with a cone of deep-yellow stamens, they are recognizable at a glance. The ripe berries are crimson-scarlet, and may be compared to red currants, only that they are oval instead of globular. The dulcamara is reckoned among the deleterious plants, but it is said not to be fatal. At all events there are no recorded cases of deadly effects. Like the belladonna, it is employed in medicine, but only to a very limited degree. The name dulcamara refers to the very curious change of taste when a bit of the stem is chewed. First it is sweet; presently it changes to bitter. The name of the belladonna is still more curious in history. The juice, in the hands of skilful oculists, has the property of causing the pupil of the eye to dilate. Hence it is resorted to in cases of operations upon the eye where dilatation is desirable. This of course is by daylight, when the operator can see perfectly what he is about. In daylight, especially when bright, the pupil contracts. In the evening, at twilight, it dilates naturally. In bygone ages the Italian ladies are said to have availed themselves of this wonderful property of the juice, in order to give richness and beauty to their eyes when, as we perceive, they would otherwise be less attractive. Thence the name *bella donna*, "beautiful lady."

FIG. 196.—SUNFLOWER. TOBACCO.

Sometimes the deleterious matter of the Solanaceæ is accompanied by abundance of starch, a vegetable substance which is invariably wholesome and nourishing. This has its finest known example in the tuber of the potato, from which the poisonous secretion is driven off by the heat employed in cooking it, and then we get the admirable mass of fecula so esteemed upon the dinner-table. There are remarkable examples also in the Solanaceæ of the poisonous matter being suppressed in favour of some powerful secretion of a hot and biting taste. Of this the best illustration is the common capsicum, used, in its different kinds, for the manufacture of "hot pickles" and of "cayenne pepper." Other very interesting plants of this order are the common henbane and the stramonium, both useful in the hands of clever medical men. Here, too, may be named the celebrated "mandrake," mentioned in the history of Rachel and Leah, and which in the middle ages, and as late as the time of Shakspeare, was the centre of a number of the wildest superstitions. The Old Testament makes mention of a second solanaceous plant, the *Solanum nigrum*, the black and shining berries of which are referred to by the prophet Isaiah under the defective translation "wild grapes."

The ornamental plants of the family are numerous, but not many are in ordinary cultivation. The most usual are certain species of Solanum, including that beautiful little red-berried plant, of which so many thousands are brought to market in the depth of winter under the name of the "winter cherry." This is the Solanum *capsicastrum*. The name of "winter cherry" pertains properly, however, to quite a different thing, though still solanaceous — the *Physalis alkekengi*, in which the imitative "cherries" consist of the enlarged and persistent calyces, green while young, scarlet in maturity. Besides these there are the lovely petunias, the daturas, and now and then the tobacco-plant, one of the most famous members of the family, though more noted for its gift to smokers than as a decorative object. Two or three edible fruits are yielded by the Solanaceæ, the prime one being the tomato. After this come the aubergine and the so-called "Cape gooseberry." Such is the extraordinary mingling of qualities and properties in this wonderful family, which, with all its variety of products, good and evil, is yet one of the best marked in regard to structure and general physiognomy.

The Gentianaceæ.

Nearly allied to the Solanaceæ stands next the very beautiful order named after the gentian—not the blue one of the flower-garden, but the yellow-flowered of the Alps, so renowned in medicine, and said to owe its name to an ancient royal physician of Illyria. The Gentianaceæ are uniformly herbaceous—for the few ligneous plants once classed with them are now placed in other families, and though, as elsewhere, a few very curious departures occur, the rule is that they shall be erect, smooth,

very neat, and prim-looking, and quite devoid of any kind of hairiness, or woolly, or cottony, or silky vesture. When to these plain features are added opposite, simple, and undivided leaves, devoid of stipules, and exceedingly pretty, if not beautiful flowers, which are almost always pentamerous, and of peculiarly bright and unalloyed colours, it is tolerably easy to distinguish a gentian-wort at first sight. The corolla is monopetalous; the stamens are epipetalous; the solitary and superior two-celled ovary becomes a capsule which discharges innumerable seeds.

These charming plants have a very wide geographical distribution. Lovely rose-coloured chironias grow at the Cape of Good Hope. The East Indies are not wanting in other species quite as attractive. On the Alps the azure gentians occur in profusion so vast as to have been a frequent subject of remark with artists and poets, not to mention the technical botanist. One with another, they seem to prefer cold and temperate countries; among them we have an example of the plants appropriately designated, from their love of snowy regions, *nivalis*. Several occur in England, the commonest and most familiar being the golden-yellow chlora and the pink erythræa, or blushwort. They are very generally found in company, especially upon airy and cheerful slopes near the sea. The true gentians, wild in our country, are less conspicuous to the general observer, though quite as interesting in the detail of their structure. Besides these, old England claims two of the very curiously exceptional species of this family—namely, the common bog-bean, or buck-bean, and the villarsia. Instead of being erect terrestrial plants, these two are floating aquatics! The villarsia seems a miniature water-lily, the leaves, which lie flat upon the surface, being oval, and the golden flowers not inconsistent with the general idea. The menyanthes, or buck-bean, has trifoliate leaves;—the white flowers, tinged externally with rose-colour, grow in clusters so like those of the hyacinth that the plant bears the elegant appellation, with many, of the "hyacinth of the marshes." This charming denizen of the standing pool gives a fair idea also of the active properties of the Gentianaceæ, whenever such properties are present, being bitter and tonic. Pure bitterness, by no means disagreeable, is a grand characteristic of the order, and there being not even a solitary instance of an unwholesome plant in it, the physician regards it as one of those peculiarly his own. For although pharmacy often looks to poisons for its most energetic auxiliaries, the *beau-ideal* of medicine, as in morals, is not so much to win by the exercise of force as to "overcome evil with good." The gentian of the apothecaries' shops is prepared from the *Gentiana lutea*, an inhabitant of the mountains of central Europe—a tall and stately plant, scarcely ever met with in gardens. The favourites, where flowers are cared for, are various species of blue-flowered gentian, especially the gentianella, which in spring and early summer opens vases of the deepest Italian blue it is possible to imagine. Nothing edible or esculent is furnished by the Gentianaceæ. Their function is to assist in mitigating pain, and to adorn the world with bloom that is rarely excelled in lustre.

Were it not that the famous "batatas," the antetype of the modern potato, is a member of the Convolvulaceæ, the last sentence would apply equally well to these. Exquisite outlines and delicious hues, *plus* a few valuable medicines, with nothing alongside that can be pronounced distinctly hurtful, form the essential attributes of an order that in several particulars has no rivals. No trees occur in it, and of shrubby plants the number is very limited, unless among the latter we count such of the tropical twiners and climbers as have ligneous stems. The word "herbaceous" covers a good deal more than is illustrated in mint and primroses. Here, amid the convolvuluses, the imagination is arrested by a display of twining power, with ascent to long distances above the level of the ground, that is rarely emulated, and in gracefulness never surpassed. A few of the species, no doubt, stand erect, but twining is the rule, as so felicitously expressed in the Latin name, and acknowledged quite as well in the English equivalent, bindweed. The stems of these beautiful plants are generally slender and wire-like; the leaves are simple, either undivided or divided, presenting many different outlines; the flowers are monopetalous, pentamerous, regular, and exquisitely campanulate—far more genuinely so than in the campanulas conventionally so called. The fruit is a dry few-seeded capsule, usually four-lobed. Opening their lovely flowers soon after sunrise, some of these plants are known familiarly by the name of morning-glories. It is only in early morning that many flowers beside convolvuluses are to be contemplated in their highest perfection. It is then that the cistuses show their splendour; then, too, that the goatsbeard, which comes to the *reveillée* of the lark, shows its delicate golden stars, and that the water-snowcups are whitest upon the pool. In our own English hedges, in early morning, there is no more lovely spectacle than that of the great white bells of the common *Convolvulus sepium*, a flower of peculiar interest to the poetic mind, since it was to this that Virgil compared Galatea, whose complexion was not less pure. The name Virgil gives the plant in question is *ligustrum*, literally "the binder"; in our own day somewhat unfortunately transferred to the privets. In addition to the great white *sepium*, we have in England, upon sandy shores, the roseate sea-convolvulus, and in limestone districts, as a common ornament of the wayside, the pretty little *Convolvulus arvensis*, in which is illustrated, by the way, in the most beautiful manner, the plaited æstivation characteristic of the order, with the lines that indicate the union, by their margins, of the five petals. Examples may sometimes be found in which the petals remain unconnected except for a short distance upwards from the base. The medicines supplied by plants of this family are jalap, and one or two others of

The Convolvulaceæ.

similar properties. The famous batatas, above mentioned, is the thick and fleshy root of an Indian kind, noted for its stimulating properties; in the days of Queen Elizabeth a common article of import from Spain, for sale in the London market, and hence associated by Shakspeare with old Sir John Falstaff, in the curious exclamation, "Let the sky rain potatoes!" The genuine potato was not then in cultivation. Some of the most beautiful of the modern garden and greenhouse Convolvulaceæ belong to the genera Pharbitis and Ipomœa.

XXXVI.

The Interjection.

§ 225. Some old interjections.
§ 226. List of interjections.
§ 227. Interjectional phrases.
§ 228. Imitative words.

§ 225. About interjections, the cries or calls suddenly thrown out in moments of emotion, there is not much more to say (*see* § 100). A few are contracted phrases, such as *grammercy* from *grand mercy!* i.e. great thanks; *marry* is a calling on the Virgin *Mary*, just as Herr Gott! is a common exclamation in German: both these are out of use. Several old interjections are curious, as *We out! herrowe!* (from Old Fr. *haro*, a cry for help), meaning oh dear! hallo! an exclamation of trouble.

It seems to have been this old shout *herrow!* or *harrow!* which was supposed to be called out by the devils in hell, and by the angels shouting after them, when Christ descended into hell to fetch out His own chosen souls, that gave to that important episode in the mediæval legends the name of the "Harrowing of Hell."

In the Yorkshire dialect of the fifteenth century "we hudde!" "we howe!" "we colle!" are the exclamations of great surprise uttered by the shepherds on seeing the star at Bethlehem.—*York Miracle Plays.*

Welaway! was an utterance of sorrow often found in old writers, for which we have now *welladay!*

"Full oft he said alas! and wel away."—Chaucer.

"Harro! and wel away!
That ever I uprose this day."
Newcastle Miracle Play, 15th century.

It is the Old Eng. phrase *wá lá wá*, i.e. *woe, lo! woe.*

§ 226. The following are some of the chief expressions of sudden feeling now in use:—

Pain. Ah! oh! O! welladay! alas! (from Old French *halas*), alack!

Surprise. Eh! ha ha! what! lo! la! lawk! aha!

Joy. Hey! heyday! hurrah! huzza! hilliho! Oh! also expresses joy; much depends on the tone of voice.

Disgust. Fie! faugh! bah! ugh! out!

Contempt. Pshah! tut!

Protestation. Indeed! marry! deuce! by jingo

Attention. Hist! hush! hark!

Calling. Holloa! ho! hoy! O yes! help!

Doubt. Hum! hem! pst!

Several interjections are from Old French, as *alas! oh! adieu! Oh!* is ambiguous, as it is ejaculated in pain, in joy, and in horror.

§ 227. Besides these there are several formed by combination with other words and phrases, as *lack a day! Ah me! O my! ifaith, adieu, for shame! dear me!* or *O dear me!* and especially many formed with verbs, as *well done! welcome, farewell, begone! woe is me!* these are really forms of speech, contracted and used interjectionally. *By jingo!* is said to come from the name of *St. Gingoulph.*

§ 228. Prof. Maetzner and Dr. Morris consider a number of imitative words—*i.e.* words framed to imitate sounds in nature or the noises made by things or animals—as interjections. Some still retain this character, others are known as familiar verbs; they have all naturally a tendency to become first nouns and then verbs, representing as they do the active speech of nature. The following are some of them:—

ding-dong	cock-a-doodle-do
tick-tack	quack
bim-bom	cuckoo
whack	tu-whit
whirr	slap
bow-wow	dash
miau	splash
caw	clank
purr	puff
twang	bubble
bang	hinny
whiz	to-whoo
thud	weke-weke
whop	baa, baa.

It would be among these imitative words that we should now place some of Ben Jonson's interjections (which he called adverbs):—

"St, a note of silence.
Rr, that serveth to set dogges together by the ears.
Hrr, to chase birds away."
English Grammar, 1640, p. 68.

An investigation into the origin and use of interjections would give some curious facts. Maetzner gives lists of well-known words—(1) rhyming substantives, adverbs, or verbs; and (2) repetitions with change of vowel, which have arisen for the most part through ejaculation. Such are:—

(1)		(2)	
	hocus-pocus		mish-mash
	hodge-podge		riff-raff
	hurly-burly		fiddle-faddle
	hugger-mugger		flim-flam
	helter-skelter		tittle-tattle
	higgledy-piggledy		snip-snap
	harum-scarum		knick-knack
	hob-nob		gew-gaw
	hoity-toity!		chit-chat

He points out that they for the most part belong to the familiarity of common life, and as a rule denote insignificant or blamable objects.

ZOOLOGY.

XI.

MONKEYS (*continued*).—MACAQUES.

THE Macaques are monkeys of moderate size, running on all fours, ranging over temperate and tropical Asia, Japan, and the great Malayan islands, and found also represented in North Africa, which is so distinctly contrasted with the rest of that continent in its animals. One of the African forms constitutes also the only European member of the monkey tribe—viz., the celebrated ape of the rock of Gibraltar. Their hind-limbs are longer than their fore-limbs, however, and in the score or more species of macaques there is great variety of length of tail and number of tail-bones. Thus the Gibraltar ape has an almost unnoticeable tail, while some have as many as eighteen bones in the long tail, which, however, is not used for prehension or grasping. These are characteristic monkeys with cheek-pouches and padded seats.

Gibraltar ape.

The more typical macaques are the Eastern ones. One of them, inhabiting Formosa, is supposed by the Chinese to be mocking their pigtail by its tail; they therefore show their keen susceptibility by depriving every macaque they catch of that appendage. Another amusing form is the Bonnet monkey, distinguished by its peculiar arrangement of hair on the crown, often with a parting down the middle. The Rhesus monkey is clever, and much regarded for its wisdom in India. The Gibraltar ape, otherwise the Barbary ape, is one of the most universally known, in science, and by the public who watch its pranks by the organ-grinder's side. It was the ape dissected by the great Galen in the second century, when human dissection was forbidden. This ape, too, is interesting to the geologist and physical geographer, for his presence on both sides of the Straits of Gibraltar is one of the evidences that Spain was once continuous land with northern Africa.

Dissected by Galen.

BABOON.

THE BABOONS.

As in India one type of apes is deified, so in Egypt, especially in the times of the old dynasties, another type, that of the baboons, has been exalted. In fact, if the baboon had been the source of all their brain-power, the Egyptians could not well have done more than they did,—worship him as a god of letters. A special sacred city, and countless sculptures, drawings, and mummies of baboons, attest the high position assigned to them. Why the baboon was also held to represent the moon we cannot conceive. Independently of the passion for baboon-keeping in Europe in the middle ages, the Egyptian remains would suffice to show how mankind have been struck with the intelligence displayed by these creatures; but much of their sense is cunning selfishness, producing very coarse and disgusting sensuality in the old males. If we want to see unpleasant reminders of some of the worst aspects of humanity, we have but to study the character of an old baboon or mandrill.

Egyptian worship.

The baboons are especially called, in science, the dog-headed monkeys. Besides having a strong resemblance to a large dog when walking, as they commonly do, on all fours, they have a very dog-like head, with a long snout and muzzle, and they possess a large smelling organ and a keen sense of smell. One species is used by the Hottentots to find water. They possess cheek-pouches—very valuable receptacles of stolen goods. The tail is comparatively small in all, and scarcely prominent in some. Their sitting-quarters are not only bare, but are often very vividly and strikingly coloured.

Sense of smell.

The baboons are not great foresters, but love rocks and plains. They are splendid rock-climbers and good runners. Their muscles and teeth are strong, and they have no fear of dogs. All of the dozen known, except one species, are African: the sacred and common baboons being north-eastern, the chacma South African, the anubis West African, the mandrill Central African and Gold Coast; while the black baboon is found far away in the East, in the great island of Celebes, telling evolutionists of a time when these islands formed part of a great continent in which lived the common ancestors of all baboons. It should be noted that baboons possess in their bony framework several peculiarities in which they are more human than the chimpanzee and gorilla.

Haunts and homes of baboons.

Most of the baboons are gregarious, and sometimes they are met in groups of hundreds. There is no doubt of their being disciplined, having leaders and scouts when on marauding expeditions. They are particularly on guard in approaching human haunts, insisting on silence being kept by the young or careless, and being astonishingly daring in their thefts. They are chiefly vegetarians, but many are fond of insects. They have no natural tendency to attack men, but will do so when annoyed or provoked, especially in captivity. They are often caught by leaving spirits or beer in their way and trapping them when drunk. In fairness we must mention that female baboons will frequently show

Large groups.

Marauding habits.

amiable qualities, and sometimes adopt the young of other species of monkeys, and even kittens and puppies.

The mandrill is a strange creature, even among this group of strange creatures. The brutal full-grown male sums up a crowd of traits as unattractive as can be, except for those who are attracted by utter repulsiveness. He is dog-like in the general shape of his body, with several peculiarities reminding us of carnivorous animals. His skull is flat-topped, from the great ridges overhanging his deep-set eyes backwards, and flanked by large and strong jaw-muscles. His canine teeth are similarly big and ferocious-looking, and above them, in the upper jaw, are great cheek-prominences of bone on either side of the nose. But the mandrill bears away the prize among mammals, we should say, for "broad effects of colour"; to prove which a glance at both ends of him, especially when angry, is sufficient. Alternate stripes of the brightest colours—scarlet, purple, blue, red—decorate his cheeks; and his great haunch-bones have bare, hard skin covering them, and this is conspicuously red. No need to say "when seen, remember," only don't give him a chance of clutching at you with his hands, or a scar too deep for pleasure may result. The mandrill is very fond of insects and scorpions, as well as corn and fruit.

The mandrill.

Considering the life of most monkeys in captivity, they are truly objects of compassion. Mr. Broderip describes a wanderoo in Regent's Park climbing his pole in an open part of the gardens, and sitting there for half an hour together, gazing wistfully at a distant portion of the park that presented the appearance of a thick wood, every now and then looking down, as if he were contrasting the smooth-shaven painted pole to which they had fettered him with the rugged living columns of the evergreen palaces of his fathers to which he was never more to return.

BONNET AND MACAQUE MONKEYS.

ALONE IN A GREAT CITY.

BY THOMAS DUNMAN.

FEW situations are more desolate than that of a young man who for the first time finds himself alone and amongst strangers in a large city. With life all around him, with thousands of his fellow-creatures constantly passing and repassing him, yet without a smile of recognition or a word of sympathy, he is more truly alone than in the solitude of a vast wilderness. As in the vicissitudes of life many of our readers may at some time or other find themselves in such circumstances, we venture to address to them a word of warning and encouragement.

To a stranger in a large city one of the most discouraging features of the busy life which he sees around him is the want of that acquaintance with and interest in each other which are so prominent in the members of smaller communities. In small towns and country villages each inhabitant is closely acquainted with every other, and even a stranger receives some notice which speedily makes him feel "quite at home." In the busy life of a large city this mutual recognition and community of interest cannot in the nature of things exist, for where so many are strangers to each other, the advent of a newcomer is unnoticed, and consequently excites no interest. Still it is unfortunate that the inhabitants of large cities are to such an extent destitute of that kindly and hospitable feeling towards strangers which exists in less crowded communities; and it would be well if those who dwell in our centres of population were to cultivate to a larger extent that fellow-feeling for others which would induce them to hold out

the right hand of fellowship to those whom they know to be respectable strangers. Too frequently town-bred people are more concerned in laughing at and mimicking the peculiarities of those from the country, than in trying to make them feel at home in the new circumstances in which they find themselves.

Perhaps the greatest difficulty which a stranger in a large city encounters is how to dispose of his leisure time. After the first novelty of his situation has worn off, and the various places of interest have been visited, the time not occupied in business is apt to hang heavily upon his hands. In a crowded city this should not, however, prove a very serious difficulty. In nearly all our large towns public libraries and reading rooms exist, which are either open free or at a nominal charge, and in these some portion at least of leisure may be profitably and pleasantly spent.

Few cities, especially during the winter season, are without numerous courses of lectures upon literary or scientific subjects, and a considerable amount of useful and interesting information may be obtained by attending some of them, while more systematic instruction may be obtained in the classes of mechanics' institutes and literary and scientific societies.

But the great want of a stranger in a large city is that of respectable and congenial social intercourse. This want is by no means so readily supplied as might be the case. Although every city and large town has its literary institutions, its clubs and its debating societies, there exists in the majority of these far too much of the class feeling, while some are professedly intended only for a certain clique. The proverbial taciturnity and reserve of the ordinary Briton is no doubt here a decided disadvantage, as it produces that indisposition to fraternise with strangers which is so great an obstacle in the way of a stranger making friends in a new sphere. Still there can be no doubt that the best course for a young man who has to remove from his early associations into a busy centre is to join one of the best known literary or scientific institutions. By so doing he will mix with suitable companions, will be in a position to improve his knowledge, and will be very unlikely to acquire pernicious habits, while he is before very long certain to form a friendship which will be of incalculable benefit.

Upon removing to a strange home, especially one in a busy city, a grand opportunity is afforded of taking up some branch of study and prosecuting it with success. While still amongst old associations it is sometimes difficult to commence and continue with determined energy a new study. Old habits have to be given up or considerably modified, the time spent in the company of old associates has to be curtailed, and a large amount of self-denial has to be practised; and man is such a creature of habit that the difficulties encountered in changing a pursuit are sometimes found insuperable, except to those possessed of an indomitable will. But in removing to an entirely new sphere, far from old associations, and with leisure time on hand, a perfectly fresh start may be made, and plans for the future may be initiated which will be fruitful for good. At such a time one's future is to a very large extent in one's own hands, and it behoves all who are so circumstanced to use the greatest discretion in arranging the disposal of their leisure hours.

Knowledge at the present day is a marketable commodity, and success in life very largely depends upon the amount which is possessed. There can therefore be no safer investment for a young man to make in first entering upon life in a large city than education. By joining some educational institution, or by the study of such a work as the UNIVERSAL INSTRUCTOR, he may not only amuse his leisure hours, but may lay up a stock of information which will greatly facilitate his journey through life. The particular subjects studied must of course depend upon circumstances, but a little consideration of present position and future prospects will serve as a guide to a wise choice. Whatever that choice may be, let the study be taken up in a resolute and determined spirit, and let no temptations induce a breach of resolution.

A source of much amusement and profit is to be found in the museums and picture galleries which most large cities possess. These, however, should be visited in a much more systematic manner than is usually the case. A museum or picture gallery is generally visited in an extremely perfunctory manner by people who go there to while away an hour or two of leisure, or because it is considered "the thing" to go. Such visitors, after wandering aimlessly about the galleries, and staring with listless eyes at the pictures or curiosities, leave the building with a feeling of having been terribly bored, and not improbably with a bad headache. This latter is largely due to having attempted too much. To visit a museum or gallery with pleasure as well as profit, it is far the best plan to take only one portion at a time and to endeavour to thoroughly understand the meaning of what is seen. To enjoy a picture it is necessary to study it, to get information from the objects in a museum it is necessary to know their history and their meaning. If young persons with unoccupied leisure on their hands were to enter upon a careful and systematic examination of the objects of interest contained in our museums and art galleries, they would find much to interest and amuse them, while in course of time a large amount of useful information would also be amassed.

Having indicated some of the ways in which leisure time in a great city may be profitably employed, we would venture to add a word of warning against the temptations which are offered to waste spare moments. One of the chief dangers to which a stranger in a great city is exposed is that of being led to give himself up to a perfect round of amusements, forgetful of his duties to himself and to his fellow-men. By this it is by no means implied that the whole of our leisure must be spent in "books or work or useful play." On the contrary, amusement and relaxation are not merely justifiable but commendable, so long as reasonable limits are not overpassed. Nevertheless

the stranger in a large city finds so many fresh sights to be seen, so many sources of amusement for the first time open to him, that he is apt to acquire the habit of occupying his leisure as if the present hour were all he has to live for, and in this way he may not only incur expenses which his income does not justify, but may lapse into an idle and unprofitable mode of life. It is necessary, while taking a fair share of pure amusement, to keep in mind the noble words of the poet:

> "Not enjoyment, and not sorrow,
> Is our destined end or way,
> But to act, that each to-morrow
> Find us farther than to-day."

A great danger of city life is that of acquiring needlessly expensive habits. The so-called artificial wants of those dwelling in large cities are undoubtedly more numerous than those of the inhabitants of quiet villages and small towns; but many of these are *purely* artificial, while some are not really wants at all. A large amount of independence of will is necessary to avoid drifting into expensive modes of living, and especially of dress, but it is without doubt much wiser to restrict as far as possible this tendency. It is better to run the risk of being thought "close" and over-careful, than to incur needless outlay. Expensive habits are much more easily acquired than abandoned, and it is wise to bear in mind that a "rainy day" may at any moment set in. Spare cash is much better laid by to provide against unexpected emergencies, than frittered away in needless trifles.

Upon commencing a career in a large city it is well to disabuse the mind of any erroneous idea of the amount of success which is likely to be attained. The old idea that the streets of a large city are paved with gold still lingers in the minds of many in a modified form. Undoubtedly, in a large city there is "a career open to talent," but it is one in which the talent must be seconded by indomitable perseverance and unflagging energy, for a great city's streets are paved not with gold, but with mud, and that frequently of a somewhat slippery character.

Nor must the stranger in a great city, especially if he be possessed of talent and ability, be surprised or dishcartened if he find that these qualifications are much less rare than in smaller places. Our great cities, and especially the metropolis, attract to themselves the best talent of the kingdom, and however accomplished a new-comer may be, he is sure to come into contact with others at least as gifted as himself.

We have not thought fit to dwell at large upon the more degrading temptations of city life, because we address those only whom we presume to be gifted with a tender conscience and a keen moral sense.

There can be no doubt, however, that these degrading temptations have proved the ruin of the brightest intellects. Every day's experience shows that high education is no sure safeguard against the snares of a great city, and does not always prove an antidote to the recklessness of youth. What is wanted is sound religious principle.

XXX.

The Pronoun (*continued*)—Theory.

3. Relative Position of Objective Pronouns after a Verb in the Imperative Affirmative.—The imp. aff., preceding the objective prons., may also precede two of them in combination. Drawing here no distinction between purely personal and reflective prons., we find that all objective prons. may follow an imperative which governs them (two of them, *me* and *te*, being changed into *moi* and *toi*); but every individual pronoun may not be combined with every other.

a. The only direct prons. that could combine with indirect ones are *le*, *la*, *les*. We leave out of reckoning *en* and *y*, of which we shall speak presently.

EXAMPLES.

envoie-LE-MOI, *send it (him) to me;*
adressez-LA-NOUS, *address it (her) to us;*
rendons-LES-LEUR, *let us return them to them;*
procure-LE-TOI, *procure it for thyself;*
adressons-LA-NOUS, *let us address it to ourselves;*
adjugez-LES-VOUS, *adjudge them to yourselves.*

(Do not forget two things here: 1st, that if the imperative is negative, all the rules given in 2 (p. 307) apply: *ne* ME L'*envoie pas*, do not send it to me; *ne* NOUS L *adressez pas*, do not address it to us; *ne* TE LE *procure pas*, do not procure it for thyself, etc. And 2nd, that for motives of emphasis or antithesis, etc., the disjunctive form could be used in the above examples: *envoyez-le* À MOI *et non à lui*, send it to me and not to him; *n'hésitez pas tant, adjugez-les* À VOUS-MÊMES, do not hesitate so much, adjudge them to yourselves.)

b. If any direct object other than *le*, *la*, *les*, came after the verb, the indirect would take the disjunctive form:

envoyez-moi À LUI, À ELLE, À EUX, À ELLES, *send me to him, to her, to them* (m.), *to them* (f.);
adresse-toi À LUI, À ELLE, etc., *apply* (*address thyself*) *to him, to her*, etc.

c. Both *en* and *y* combine with every direct or indirect pronoun, and come last.

EXAMPLES.

donnez-M'EN (for *moi en*), *give me some* (*of it*);
achète-T'EN (for *toi en*), *buy some for thyself;*
promettons-LEUR-EN, *let us promise some to them.*

The above offer *en* in connection with the indirect object; the following show it with the direct:

ramenez-M'EN (for *moi en*), *bring me back from it;*
rachetons-NOUS-EN, *let us redeem ourselves from him;*
corrige-T'EN (for *toi en*), *correct yourself of it;*
mène-M'Y (for *moi-y*), *lead me to it* (*there*);
rends-T'Y (toi-y), *betake thyself to it* (do.);
envoyons-L'Y (le-y), *let us send him there;*
portons-L'Y (la-y), *let us carry her there;*
menez-NOUS-Y, *take us thither;*
fiez-VOUS-Y, *trust it* (*trust yourself to it, him, her, them*);
conduisez-LES-Y, *conduct them to it* (*there*).

Remark.—One may also say *mènes-y-moi*, *menez-y-moi*, *confies-y-toi*, *tiens-y-toi*, *prépares-y-toi*, etc. The construction given in the examples is preferable, because the latter, though regular, seems to grate on French ears. [It must be borne in mind that in *mènes-y*, *mènes* takes the *s* for the sake of euphony (see p. 200). To say, however, *vas y donner des ordres* would be a

mistake, because *y* does not belong to *va*, but is an indirect object to *donner*; write *va y donner des ordres*. From this fact we draw the inference that a verb may be altered for the sake of euphony only in connection with its own pronouns.]

d. *y* also combines with *en*, and precedes it: expédiez-y-en, *forward to it some*.

4. PLACE OF THE OBJECTIVE PRONOUN WHEN THE GOVERNING VERB IS FOLLOWED BY AN INFINITIVE, WITHOUT PREPOSITION.

a. The object should stand before the verb which governs it: *je désire le voir*, I wish to see him; *il faudrait pouvoir en profiter*, it would be well to be able to take advantage of it.

b. Yet in poetic language, and sustained style generally, we may sometimes find the object of the infinitive standing before the first verb: *je t'en veux assurer*, I wish to assure thee of it, instead of *je veux t'en assurer*.

c. If the first verb is some part of *entendre*, to hear, *faire*, to cause, *laisser*, to allow, *ouïr*, to hear, or *voir*, to see, no choice is left. The objective pronoun owned by the infinitive precedes the first verb.

EXAMPLES.

1. je l'entends gronder.
2. il me fait battre.
3. il m'a laissé voler.
4. je le vois dépouiller.

Such phrases present one of the real difficulties of the language; they are strictly correct, and nevertheless each offers a double meaning:

1. = *either* I hear him scold *or* I hear (some one) scold him;
2. = *either* he causes me to beat *or* he causes (some one) to beat me;
3. = *either* he allowed me to steal *or* he let (some one) rob me;
4. = *either* I see him strip (something) *or* I see (some one) strip him.

It is only because we ascribe to those four phrases the latter meaning, that we are justified in saying that, although the objective pronoun belongs *to the infinitive*, it stands before the first verb. [This rule *c* will find a most important application when we reach the chapter on the past participle. It will interest the student of German to hear that that language presents the same weakness: *er lässt mich schlagen* strictly means *he lets me beat*, or *he lets some one beat me*. The English, by using here the passive, solve the difficulty: *he lets me beat*, and *he lets me be beaten*; or *he causes me to beat*, and *he causes me to be beaten*.]

Practical Application.

(1) Conjugation of *vendre*, to sell, model of verbs in *re* (4th conjugation).

INFINITIVE.

Present.	*Past.*
vendRE, *to sell.*	avoir vendu, *to have sold.*

PARTICIPLE.

Present.	*Past.*
vendANT *selling.*	vendU, *sold;* ayant vendu, *having sold.*

INDICATIVE.

Present.	*Perfect Definite.*
je vends, *I sell*	je vendIS, *I sold*
tu vends, *thou sellest*	tu vendIS, *thou soldest*
il vend, *he sells*	il vendIT, *he sold*
nous vendONS, *we sell*	nous vendÎMES, *we sold*
vous vendEZ, *you sell*	vous vendÎTES, *you sold*
ils vendENT, *they sell*	ils vendIRENT, *they sold*
Imperfect.	*Future Absolute.*
je vendAIS, *I was selling, etc.*	je vendRAI, *I shall sell, etc.*
tu vendAIS	tu vendRAS
il vendAIT	il vendRA
nous vendIONS	nous vendRONS
vous vendIEZ	vous vendREZ
ils vendAIENT	ils vendRONT

Compound Tenses.

Perfect Indefinite: j'ai vendu, *I have sold, etc.*
Pluperfect: j'avais vendu, *I had sold, etc.*
Perfect Anterior: j'eus vendu, *I had sold, etc.*
Future Anterior: j'aurai vendu, *I shall have sold, etc.*

CONDITIONAL.

Present or Future.		*Past.*	
je vendRAIS	*I should sell, etc.*	j'aurais (eusse) vendu	*I should have sold, etc.*
tu vendRAIS		aurais (eusses) vendu	
il vendRAIT		aurait (eût) vendu	
nous vendRIONS		aurions (eussions) vendu	
vous vendRIEZ		auriez (eussiez) vendu	
ils vendRAIENT		auraient (eussent) vendu	

IMPERATIVE.

vends, *sell thou.*
qu'il vendE, *let him sell.*
vendONS, *let us sell.*
vendEZ, *sell ye.*
qu'ils vendENT, *let them sell.*

SUBJUNCTIVE.

Present.		*Imperfect.*	
que je vendE	*That I may sell, etc.*	que je vendisse	*That I might sell, etc.*
que tu vendES		que tu vendisses	
qu'il vendE		qu'il vendît	
que nous vendIONS		que nous vendissions	
que vous vendIEZ		que vous vendissiez	
qu'ils vendENT		qu'ils vendissent	

Compound Tenses.

Perfect Definite: que j'aie vendu, *that I may have sold, etc.*
Pluperfect: que j'eusse vendu, *that I might have sold, etc.*

(2) Verbs conjugated like *vendre:*

rend*re, to return*	répond*re, to answer*
fend*re, to split*	attend*re, to await*
suspend*re, to hang up*	descend*re, to bring down*
tond*re, to shear*	tord*re, to twist*
fond*re, to melt*	mord*re, to bite*
	entend*re, to hear*

EXERCISE XLIII.

(This exercise illustrates the simpler facts connected with the arrangement of objective pronouns in connection with their governing verbs; the learner's attention is called to rules *a*, *b*, and *d* of 2, and *a* of 3 in the foregoing lesson.)

1. She sells it (*m.*) to me; she was selling it (*f.*) to me; she sold them to me. 2. I sell them to thee; I do not sell it (*f.*) to thee; do I sell it (*m.*) to thee? do I not sell them to thee? 3. They return them to us; they were returning it (*m.*) to us; they returned it (*f.*)

to us. 4. We return them to you; we do not return it (*f.*) to you; do we return it (*m.*) to you? do we not return it to you? 5. I would split them *for* (to) him; thou wouldst split them for her; he would split them for them. 6. *I wish you to hang them up for me* (I wish = *je veux*, that you may hang them up to me); I wish him to hang it (*m.*) up for thee; I wish her to hang it (*f.*) up for us. 7. *He would wish me to shear it for him* (would wish = *voudrait*, that I might shear it to him); he would not wish us to shear them for him; she would wish you to shear those sheep (*ces moutons*) for her. 8. I would melt them for you if you would answer (*to*) me. 9. He sells (*to*) me some (*of it*); I sell (*to*) thee some; thou sellest (*to*) him some; we sell (*to*) her some; you sell them some; they sell you some. 10. You will not return to me any (*of it*); will you return to me any? 11. He awaits me there; I was not awaiting thee there; she did await him there; he did not await her there. 12. Should we await you there? 13. Bring (*thou*) it (*m.*) down to me; bring (*thou*) it (*f.*) down to her; bring (*thou*) them down to thy uncle. 14. Let us sell them to her; let us not sell it (*f.*) to them. 15. Let him twist it; let him answer (*to*) her; let him bite you; let him not hear it. 16. Return (*ye*) some to me; return (*ye*) some to him; return (*ye*) some to us. 17. Await (*thou*) me there; let us not await him there. 18. I was wishing him to answer you (was wishing = *désirais* that he might answer *to* you); I was wishing her to answer (*to*) my letters (*mes lettres*).

XXXIII.

Growth of the Grecian States (*continued*).

Though politically disunited, there were some Greek institutions common to all the states, which formed some slight bond of union between them. There were many religious and athletic meetings at which all the states used to come together. Of the religious meetings the most celebrated was the "Amphictyonic Council," whose chief duty was to watch over and guard the temple of Apollo at Delphi, and that of Demeter (Ceres) at Thermopylæ. For this purpose it met once a year at each of these places. It was composed of deputies sent by twelve tribes, each of which comprised several independent states, the names of which prove the great antiquity of the council, and show that it must have originated in pre-historic times.

Amphictyonic Council.

We get a good idea of its duties from the oath which its members had to take:—"We will not destroy any Amphictyonic town nor cut it off from running water in war or peace: if any one shall do so we will march against him and destroy his city. If any one shall

Amphictyonic oath.

VIEW NEAR THERMOPYLÆ.

plunder the property of the god, or shall be cognizant thercof, or shall take treacherous council against the things in his temple at Delphi, we will punish him with foot and hand and voice, and by every means in our power."

From this it appears that the chief duties of the council were to restrain acts of aggression against the states represented in it, and to guard the temple at Delphi. It was not a league for the purpose of defence against invaders of their country, but when the rights or dignities of the temple at Delphi were violated, they united to punish the sacrilegious invader; and several wars arising in this way, and called "sacred wars," are recorded. As is usual with so-called "sacred wars," they are amongst the bitterest and bloodiest on record.

Sacred wars.

There were four great meetings or festivals for athletic, and in later times for literary and musical contests, or "games," as they were called. These were the Olympic, the Pythian, the Isthmian, and the Nemean games. They were probably of greater efficacy than the Amphictyonic council in promoting a feeling of brotherhood among the Greeks. They were open to the competition of all who could prove themselves of Hellenic blood, and were frequented by great numbers of spectators from all parts of the Greek world. The most ancient and most famous of these games was the festival held at Olympia, near an ancient temple of Olympian Jove. Its origin is lost in antiquity, and the first allusions to it in Greek authors treat it as already an ancient institution. It is said to have been revived by Lykurgus, the great Spartan legislator, of whom we shall have more to say hereafter, about the year 776 B.C.; and accordingly this year was afterwards taken as a chronological starting-point from which the Greeks reckoned time. This festival was celebrated at the end of every four years, and the period between two successive festivals was called an Olympiad. Thus the year 736 B.C. would be called by the Greeks the tenth olympiad, because it is forty years or ten olympiads after the first. While this festival lasted, and for some weeks before and after, all hostilities cease l throughout Greece, and the territory of the state in which it took place was during its continuance considered sacred, so that no armed force could enter it without incurring the guilt of sacrilege. Deputies from the various states attended, and vied with each other in the magnificence of their offerings to the temple. The contests consisted of racing, both on foot and on horseback, and in chariots, wrestling, boxing, jumping, throwing the quoit and the javelin. The prize offered to the victor was a garland of olive leaves, but the real prize was the honour and glory which he gained throughout the whole Greek world, and the privileges which his native state conferred on him. He was generally relieved from the payment of taxes, and in some cases was presented with a considerable sum of money, and he had a right to the front place at all public entertainments. The Spartans rewarded a victorious fellow-countryman by allowing him a place in battle near the person of their king. These games continued to be held for more than a thousand years, and were only abolished in A.D. 394 by the Emperor Theodosius, long after the liberty of Greece itself had fallen before the Roman legions. The Pythian, Nemean, and Isthmian games were at first confined to the people of the state in which they took place, but gradually they were thrown open to all Greeks, and became scarcely less celebrated than the Olympic.

Games.

Olympic games.

Other games.

We have spoken of the Delphic oracle. There were many sacred spots in Greece where the gods could be consulted through the priest or priestess of the temple. But that of Apollo at Delphi was by far the most renowned. No great undertaking was begun without, if possible, consulting the Delphic oracle. Foreigners came long distances—even from Rome itself—to consult it. The temple at Delphi was built over a small opening in the ground from which a peculiar vapour ascended. Such openings are common enough to this day in all volcanic countries. Over this chasm a tripod or three-legged stool was placed, and when the god was to be consulted a virgin priestess, called Pythia, took her seat on the tripod; the vapours were supposed to, and possibly did actually, affect her brain, so that her answers were considered to be those of the god speaking through her. They were in verse, and generally capable of two opposite meanings, so that the inquirer could please himself and follow the advice which he preferred; while if it eventually appeared that the advice adopted was not wise, the credit of the oracle was saved by pointing to the other meaning and laying the blame on the inquirer's own stupidity in misunderstanding the god's answer. When the oracle was quite at fault, and could neither invent an equivocal answer nor venture to give a plain one, the priestess fell back on obscurity and gave a reply which they could make nothing of. It continued to be revered and consulted for many centuries, holding its ground with the tenacity which religious superstitions of all kinds exhibit among even the most civilized peoples in modern as well as ancient times. It is probable that the priests were more learned and wiser than the majority of their inquirers, and were forced by the frequency of these inquiries to keep themselves acquainted with what was going on in the world, and to watch the course of events and try to forecast them; so that no doubt in many cases they were qualified to give valuable advice. Unfortunately they did not confine their advice to these cases, nor could they afford to let it be supposed that the god was ever unable to offer any advice or to prophesy the results of a proposed undertaking. In later times, too, they became corrupted by the bribes of those who wished to buy the support of the oracle.

Oracles.

Rise of Sparta.

At the epoch of the first olympiad, Sparta was certainly not the largest or most powerful of the Dorian states. That position appears to

have been occupied by Argos, which was at the head of a league or confederacy of Dorian states. But during the two centuries and a half following the first olympiad, Sparta gradually rose to the first place in Greece.

This rise of Sparta was undoubtedly greatly assisted by, if not due to, the peculiar institutions forced upon her by Lykurgus. This remarkable man flourished about the time of the first olympiad, *i.e.* in B.C. 776; for, as we have seen, he revived the Olympic games in that year. He was a younger brother of one of the two kings who by an unusual arrangement ruled over Sparta simultaneously. His brother died leaving his queen with child. The mother offered to destroy her child, and so let Lykurgus become king, if he would share his throne with her. He pretended to consent, but when the child was born he presented it to the people in the market-place as their future king. The mother took revenge by accusing him of designs upon the child's life. He went into voluntary exile, and travelled much in foreign lands, visiting Egypt, and some say even India. On his return after many years he found his native city in great disorder and sadly in want of reform. He consulted the oracle of Delphi, and was encouraged to attempt sweeping reforms. By a *coup d'état* he made himself supreme, and his nephew the young king soon recognized the wisdom of his proposals, and acquiesced in them. He now issued a series of ordinances, the results of long meditation and comparison of the institutions of various states. These ordinances aimed at, and in the end effected, a complete revolution, not only in the political constitution and military organization of the country, but also in the social and domestic life of the people. There was violent opposition at first to his reforms, as was but natural; but with indomitable courage and determination he carried them to a successful issue, and all classes agreed to obey them. He then exacted a solemn promise from the people that they would change none of his laws until he should return from a second grand journey which he proposed to take; and he then set out again on his travels with the firm determination never to return, that so his laws might be perpetual. Whither he went and where he died no one knew. He vanished like a god from earth, and he was honoured like a god down to the latest times of Sparta's existence.

Lykurgus.

To understand his system we must bear in mind that the Spartans were a small body of conquerors in the midst of a conquered and hostile population of a different tribe, and far outnumbering themselves. The main object of Lykurgus was to organize and discipline this small body, so that they should be able to keep the subject race under their power. His system has been described as one which "combined the ascetic rigours of a monastery with the stern discipline of a garrison," and history affords no parallel instance of a whole nation, including both sexes, voluntarily submitting to a discipline so severe. Every detail of a Spartan's life, from his very birth until he reached the age of sixty, was under the immediate control and searching inspection of the state. When born he was exhibited in public, and if delicate or deformed, was exposed to die on Mount Taygetus. At seven he left his home and joined the public classes. He was drilled as a full-grown soldier, practised unceasingly in gymnastics, and compelled to submit without a complaint to the most cruel hardships, hunger, thirst, heat, cold. As a test of endurance of pain he was publicly flogged at the altar of Diana till the blood gushed over all the altar. His parents looked on; and if, as often happened, the child died under the lash without a complaint, the mother felt happy in having borne such an excellent child. To make them bold and dexterous in stratagems, children were encouraged even to steal; but if detected they were severely punished—not for the theft, but for their clumsiness in letting themselves be found out. Plutarch tells the well-known tale of the Spartan lad who had stolen a fox and concealed it under his coat, where he suffered it to eat into his very bowels rather than be detected. The story, whether true or false, illustrates the manners of the time.

Lykurgus' system.

Training of a Spartan youth.

The Spartan youth received a very scanty literary education. Long speeches they were taught to despise, so that "Laconic," another name for Spartan, came to mean brief in speech. Music was almost the only art tolerated, and that only for martial purposes. A Spartan was not considered of full age until he was thirty, and was not allowed to marry or take any part in public affairs until that age. Even then he was not allowed to live at home with his wife, or even take his meals at home. He had his meals and slept at night in the public barracks. And this discipline was kept up till he was sixty years of age. Even the women, until they married, were subject to a rigid discipline and severe bodily exercise—running, wrestling, boxing with each other. At twenty a Spartan maiden generally married, and thenceforth was free from public discipline. She seldom saw her husband, but was well treated and better off on the whole than women in other Greek states. Her great ambition was to do what she was taught to consider her highest duty—to bring up strong and manly children for the service of the state, and willingly she gave them up to the state: "Return either with your shield or upon it," was her exhortation to her son or husband setting out to battle. The greatest conceivable disgrace was to be the mother of a coward, who had flung away his shield in flight. So rigidly conservative were the Spartans that strangers were not allowed to reside in Sparta, nor were Spartans allowed to go abroad without leave, lest their manners and customs should become changed by intercourse with others. They were forbidden to go to war too often with the same people, lest the latter should learn their military secrets; and their city was never fortified, so that they might be compelled to keep a vigilant guard against surprise.

Spartan women.

Conservatism.

X.

Force-Diagrams, Triangle of Forces.

§ 44. We shall now find it desirable to make use of a certain method of representing forces which will enable us to solve many mechanical problems by merely drawing figures to scale. It consists in indicating a force by a straight line, the direction of which shows the direction of the force, while its length shows the magnitude of the force or the number of poundals in the force.

Representation of forces.

In order to get valuable results from this mode of representing forces, we must bear in mind what is meant by the direction and magnitude of a force. The *direction* of a force is the direction in which a change of motion takes place when that force alone acts upon the moving body. The magnitude of a force is measured by the effect produced; and this measurement may take any one of several different forms—which however are all equivalent. For instance, the magnitude of the force may be given by the change of momentum produced in a second, or by the change of energy of motion effected while the body moves over one foot; and these give, as we have already seen, identical results. For our present purpose another measure, equivalent to the preceding, will be more convenient. When a force acts upon a body at rest it will in a given time, say one second, cause it to move through a certain distance. It is clear that the greater the force the greater this distance will be; and a reference to § 15 will show that as a fact this distance is proportional to the acceleration. Hence, unless we have to consider bodies of different masses, the distance traversed in one second by a body, starting from rest, may be taken as a measure of the force. It is easy to verify this with Atwood's machine. Let weights of 1 poundal, 2 poundals, $2\frac{1}{2}$ poundals, (for instance) set in motion a mass of 1 lb. You will find the distances passed over in one second are about 6 inches, 12 inches, and 15 inches respectively; which are proportional to the forces. Of course, in trying these experiments care must be taken to neutralize friction as far as possible, and it must be remembered that the pulley is part of the mass set in motion. Unless these points are observed the results may be very far from reliable.

Magnitude of a force.

When, therefore, it is said that a force is represented by a line AB, we may take it to mean that the force would cause a body of a certain mass to move from A to B in one second, supposing the body to have been at rest to begin with.

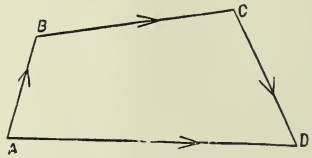


FIG. 21.

§ 45. With this in our minds, we will try to find out the effect of two or more forces acting at the same time upon a body at rest; and first let us take the case of two forces. In fig. 22, the line AB may represent one force, the line AC another. If the force AB alone were to act upon a body at rest it would in one second make it move from A to B, or from C to D, if CD be drawn in the same direction and of the same length as AB. If the force represented by AC were to act by itself upon the same body it would make the body move from A to C in one second, or from B to D if we make BD parallel and equal to AC. If both forces were to act at the same time they would make the body move from A to D in one second.

A very important conclusion is that the two forces AB, AC acting together will produce just the same effect as one force AD; so that we may replace the two forces by one which is equivalent to them and is called the "resultant."

Resultant.

In the same way we may deal with the effect of several forces. For instance, in fig. 21 the force represented by AB would move a body from A to B in one second, supposing the body to have been at rest at first. The next force would move it from B to C in one second; the next from C to D,—in each case supposing the body to start from rest. If all the forces were to act at once they would in one second cause the body to pass from A to D. The single force AD would have just the same effect, and this single force is the resultant of the three forces denoted by AB, BC, CD. There is no difficulty in dealing with any number of forces in this way. Each force is represented in direction and magnitude by a straight line which starts from the end of its predecessor. The straight line that joins the first point of the figure to the last represents the resultant of all the forces. It must be remembered, however, that in this we say nothing about whether the forces make the body *turn round*,—we are talking now simply of the effect of the forces in making the body pass from place to place without considering any rotary motion.

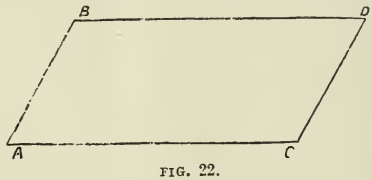


FIG. 22.

For the sake of simplicity we have supposed the body acted upon to be at rest when the forces began to act. The question now arises, What will happen if the body is moving at first? If you remember what was said in § 7, you will see that the fact of a body being at rest or in motion when the forces begin to act upon it makes no real difference. The motion produced by the new forces is

simply added to the motion already occurring, and the "addition" is performed in the way described in § 11.

Polygon of forces.

§ 46. There is a special case of several forces acting on a body which calls for remark, since it is capable of being easily verified by experiment, Moreover, this particular case is that which is of the most general use in dealing with mechanical problems. It is when the diagram of forces, drawn as above described, makes a complete circuit, so that the first and last points of the diagram are the same. An example is shown in fig. 23. We have here four forces: the first would cause the body to move from A to B; the second from B to C; the third from C to D; the last from D to A, in one second. If all were to act together they would cause the body to move—how far? Why, from A to A: that is, they would not make it move at all, provided they did not make it turn round. If the body were at rest to begin with, it would remain at rest; if it were in motion, the motion would not be affected by these forces, except perhaps in the matter of rotation. Another mode of expressing this is to say that the resultant of the forces vanishes.

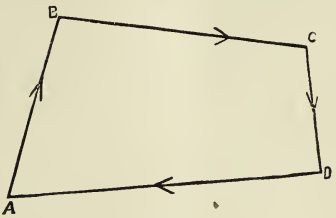


FIG. 23.

§ 47. It is easy to verify the results of § 46 experimentally. For this purpose we require a few pulleys, which should be so mounted that they can readily be attached, with their axles horizontal, to the edges of a table or bench. Over each of the pulleys, when in position, passes a supple cord, on one end of which is suspended a "weight" similar to those used in Atwood's machine. The other end is attached to a small brass ring lying on the table. Suppose three or four of the cords to be connected with the ring.

Experimental verification.

The ring then represents the body acted on by the forces. The direction of each force is given by the direction of the corresponding string, and the magnitude of the force by the weight of the mass hanging on the string. The strings will in fact form a diagram in the air, lying near to the surface of the table; and it is a very simple matter to compare this with our diagram drawn according to rule. It is only necessary to fix in the proper position upon the table the paper on which the figure has been drawn. Or the process may be reversed by fixing a blank sheet of paper on the table, marking off the direction and magnitude of each force—thus copying, as it were, the string diagram. If the paper be now removed we can test the copy by the process of § 46. It must be remembered that our experiment is a rough one, so that the test will rarely be satisfied exactly. The magnitudes of the several forces are not accurately determined. For, even if the weights are just what we estimate them, the friction of the pulleys vitiates the results. The amount of this friction may be ascertained by some preliminary experiments; and if allowance be made by adding a weight to each cord just sufficient to overcome the friction, the string diagrams will be found proportionally improved.

§ 48. It will be worth while to give a short account of the mode of experimenting, because we shall thus not only avoid a very frequent misconception, but shall also be making some advance in the practical application of our results. As an example we will suppose that we wish to verify the diagram in fig. 23. The first thing to do is to draw the plan of the strings. For this purpose any convenient point, O, on the paper is taken to represent the centre of the ring, and lines are drawn from the point parallel to the lines in fig. 23. They must be so drawn that all the forces act from the point O; for a string can only pull—it cannot push. We thus get a plan such as that shown in fig. 24, where the numbers attached to the different lines indicate the magnitudes of the forces. Very often the two diagrams, figs. 23 and 24, are drawn in one, the point O being placed at A, B, C, or D, of the former diagram. This saves a little trouble, but it is likely to lead to confusion, at any rate at first. Our diagram, fig. 24, being completed, it is fixed upon the table. The ring is held so that its centre comes just over O. Four pulleys are then fixed round the table in such positions that the strings will have their proper directions as given by the plan. Finally, at the hanging ends of the strings masses are attached whose weights are 3, 4, 2, 5 units respectively. If the ring be released it will be found to remain at rest. If it be moved out of position the relative directions of the strings will be changed, and the ring will probably begin to move towards the point O when released. Or again, if the ring be put in its original position, so that the strings have their proper directions, and the weights altered, it will be found that the ring will, generally speaking, begin to move when released. If, however, all the weights were doubled or halved, the equilibrium would still continue. These effects are somewhat masked by the unavoidable friction; but a few sharp taps on the table given in the course of conducting the experiment will often betray a sham resting-place.

An example.

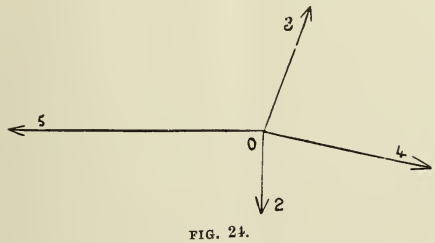


FIG. 24.

XXXVIII.

The Possessive Pronouns.

The possessive pronouns mein (my), dein (thy), sein (his or its), ihr (her and their), unser (our), euer (your), are declined exactly like the indefinite article ein, eine, ein—for the singular; for the plural they have, like the definite article, the endings e, er, en, e, for the nom., gen., dat., and accusative respectively:

	Singular.			*Plural.*
	Mas.	Fem.	Neut.	(of all genders.)
Nom.	mein *mine*	meine *mine'-e*	mein *mine*	meine *my'-ne*
Gen.	meines *my'-nes*	meiner *my'-nerr*	meines *my'-nes*	meiner *my'-nerr*
Dat.	meinem *my'-nem*	meiner *my'-nerr*	meinem *my'-nem*	meinen *my'-nen*
Acc.	meinen *my'-ner*	meine *my'-ne*	mein *mine*	meine *my'-ne*

The remaining possessive pronouns are declined in the same way:

	Singular.			
Pers.	Masc.	Fem.	Neut.	Gen.
1st	mein *mine*	meine	mein, my	meines, etc.
2nd	dein *dine*	deine	dein, thy	deines, etc.
3rd masc.	sein *zine*	seine	sein, his	seines, etc.
3rd fem.	ihr *eerr*	ihre	ihr, her	ihres, etc.
3rd neut.	sein *zine*	seine	sein, its	seines, etc.
	Plural.			
1st	unser *un'-zer*	unsere	unser, our	unseres, etc.
2nd	euer *oy'-err*	euere	euer, your	eures, etc.
3rd	ihr *eerr*	ihre	ihr, their	ihres, etc.

When the possessive pronoun is used after a substantive, and the noun is not repeated, the syllable er is generally added; thus—His hat and mine, sein Hut und meiner. Another form frequently employed is (like the French *le mien, le sien*, etc.) der meinige, der deinige, etc. When there is no comparison or connection indicated between two or more things, the plain mein, dein, sein, etc., is used. Thus dieses Messer ist mein, this knife is mine (*à moi*, belongs to me); dieses Messer ist das meinige, this knife is mine, contrasted with one or more others belonging to some one else (*le mien*).

Study on the Possessive Pronouns.

Die Söhne Wilhelms des Ersten em-
dee zoeh'-ne vil'-helms des errs'-ten em-
pörten sich gegen ihren Vater Von
poer-ten zych gay'-gen ee'-ren fah'-terr fon
meinem Freunde habe ich es erfahren.
my'-nem froin'-de hah'-be ich ess err-fah'-ren
Er hat sich die Hand verletzt. Luther
airr hat zych dee hand ver-letzt loo'-terr
war der Prophet seiner Zeit. Einem
vahr dare pro-phayt' zy'-nerr tsite i'-nem
beliebten Führer folgen seine Soldaten
be-leeb'-ten fue'-rer fol'-gen zy'-ne zol-dah'-ten
gern. Die Habsucht verleitet die Men-
gerrn dee hahb'-zucht fer-ly'-tet dee men'-
schen, daß sie zu sehr an ihren eigenen
shen dass zee tsoo zayr an ee'-ren i'-ge-nen
Vortheil denken. Wir sollen unserem
forr'-tile denk'-en veerr zoll'-en un'-ze-rem
Nachsten gutes thun, selbst wenn er
naych'-sten goot'-es toon zelbst venn ayrr
seine Pflicht vergessen sollte. In seiner
zy'-ne pflicht fer-ges'-sen zoll'-te in zy'-nerr
Geschichte des dreißig jährigen Krieges
ge-shich'-te dess dryss'-ich yähr'-ig-en kree'-ges
hat Schiller das Verbrechen Wallenstein's
hat shil'-lerr dass fer-bre'-chen val'-len-stynss
erklärt. Auf Ihren Reisen, mein junger
er-klayrt' orff ee'-ren ry'-zen mine yung'-er
Freund, haben Sie gewiß die Erfahrung
froind hah'-ben zee ge-wiss' dee er-fah'-rung
gemacht, daß man mit sanften Mitteln
ge-macht' dass man mit zannft'-en mit'-teln
am weitesten kommt. Meine Meinung ist
am vy'-test-en kommt my'-ne my'-nung ist
vielleicht nicht besser als die Ihrige;
feel-lycht nieht bes'-ser als dee ee'-ri-ge
aber ich beharre bei der meinigen.
ah'-ber ich be-har'-re by dare my'-ni-gen
Diese Brieftasche ist mein; wo hat der
dee'-ze brief'-tash-e ist mine vo hat dare
Mann dieselbe gefunden? Gestern war
mann dee-zel'-be ge-fund'-en guest'-ern vahr
ich in London und ich besuchte die Ihrigen;
ich in lon-don unt ich be-zooch-te dee ee'-ri-chen
sie befanden sich alle wohl. Sein Kutscher
zee be-fand'-en zich al'-le vole zine kut'-sher
war da, als wir auf dem Platze kamen:
vahr dah als veerr orff dame platt-se kah'-men
der meinige war nicht zu finden; der
dare my'-ni-ge vahr nicht tsoo finnd'-en dare
Ihrige war auch nicht da. Dieser edle
ee'-ri-ge vahr owch nicht dah dee'-zer ayd'-le
Mann hatte von meinem Mißgeschick
mann hat'-te fon my'-nem miss'-ge-shick
gehört, und bot mir seine Freundschaft
ge-hoert' unt bote meerr zy'-ne froind'-shaft
an. Er schrieb den Brief im Namen
an airr shreeb dane breef im nah-men
seines Sohnes und seiner Tochter. Die
zy'-nes zohn'-es unt zy'-nerr toch'-terr dee
Versuche Philipps des Zweiten, England
fer-zoo'-che pheel'-ipps dess tsvy'-ten enn'-glant
mittelst seiner großen Flotte zu ero-
mit'-telst zy'-ner gross'-en flott'-e tsoo er-oh'-
bern waren vergebens. Meinen besten
bern rah'-ren fer-gay'-bens my'-nen best'-en

Freund habe ich im Laufe dieſes letzten
froind hah'-be ich im lowf'-e dee'-zes lets'-ten
Jahres verloren. Kinder, ihr werdet
yahr'-es fer-lohr'-en kind'-err eerr verr'-det
euer Zeugniß erhalten, ehe ihr heute
oi'-err tsoig'-niss er-halt'-en ay'-e eerr hoi'-te
nach Hauſe geht.
nach how'-se gayt

VOCABULARY.

ſich empören,[1] to revolt
zich em-pöh'-ren
(pres. ich empöre mich, imp. ich em-
ich em-pöh're mich ich em-
pörte mich, past part. empört)
pöhr'-te mich em-pöhrt'
erfahren, to learn (receive intelligence con-
err-fahr'-en [cerning a fact, also to experience)
verletzen, to injure
ferr-lets'-en
beliebt, popular, favourite
be-leept'
die Habſucht,[2] avarice
dee hahb'-zucht
der Vortheil, the advantage
dare fore'-tile
das Verbrechen,[3] the crime
dass fer-brech'-en
ſanft, gentle
das Mittel, the means
dass mit'-tel
die Meinung, the opinion
dee my'-nung [stand upon) something
auf etwas beharren, to maintain (take a
orf et-'vas be-harr'-en
die Brieftaſche,[4] the pocket-book
dee breef'-tah-she
die Ihrigen, your (family)
dee ee'-ri-gen
ſich befinden, to find oneself (with regard to
zich be-fin'-den [health—French *se porter*)
das Mißgeſchick,[5] the misfortune
dass miss'-ge-shick
anbieten (ich biete an, ich bot an, ange-
an-bee'-ten ich bee'-te an ich bote an an'-ge-
[boten), to offer
boh-ten
mittelſt, by means of
mit'-telst
vergebens,[6] in vain
fer-gay'-bens
das Zeugniß,[7] the mark, certificate
dass tsoig'-niss
erhalten (ich erhatte, ich erhielt, past part.
er-halt'-en [erhalten), to receive

OBSERVATIONS.

[1] *Sich empören*, to rise in insurrection, to revolt, is a reflective verb—*ich empöre mich, du empörst dich*, etc. It comes from the word *empor*, upward: *Der Nebel stieg aus den Thälern empor*, The mist rose upward from the valleys.

[2] *Die Habsucht* comes from *haben*, to have, and *suchen*, to seek, *die Sucht* being the seeking or tendency. Thus the seeking to have or possess.

[3] *Das Verbrechen*, the crime; from *brechen*, to break, in the sense of breaking the law, and *ver*, in the sense of astray or aside.

[4] *Die Brieftasche*, from *der Brief*, the letter, and *die Tasche*, the pocket; literally a pocket for letters.

[5] *Das Mißgeschick*, from the prefix *mis*, like the English equivalent in *mis*nomer, and *das Geschick*, fate; from *schicken*, to send; literally, adverse fate or destiny.

'*Vergebens: ver* means here, away, and *geben*, to give, in the sense of what is given in vain or without equivalent.

[7] *Das Zeugnisz* has several meanings. In the first place it means testimony: thus, *der Zeuge*, the witness; *falsches Zeugnisz*, false witness. Secondly, it means a certificate (report given to a scholar. etc.), for a certificate bears witness or testifies to certain facts.

XXXVI.

PART II.

ORGANIC CHEMISTRY.

ORGANIC CHEMISTRY has already been defined to be the history of the carbon compounds; and, in truth, this element forms an endless series of combinations with other elements, entering more or less largely into the infinitely various organic constituents of the bodies of animals and plants. If any portion of an organic structure be subject to partial or imperfect combustion, we shall find, when the more volatile constituents have been driven off by heat, that the residuum consists in every case of solid carbon. If a piece of wood, a piece of bread, a piece of sugar, and a piece of meat be exposed to the action of heat in a closed vessel, the result will in every case be the formation of a black porous substance identical with charcoal or lamp-black. Sulphuric acid, if dropped upon sugar, will, by depriving it of its hydrogen and oxygen, convert it into a mass of charcoal.

The carbon compounds.

Decomposition of organic compounds.

Sulphuric acid and sugar.

When we examine into the ultimate chemical constituents of plants and animals, we find that while the organic components of both contain carbon, those of the latter are far richer in nitrogen than the former. This element enters but sparingly into the greater number of vegetal compounds.

Animal and vegetal organisms.

We shall proceed, in the first instance, to consider some of the principal vegetal or non-azotised compounds. The cellular tissue of which the bodies of young and tender plants principally consists gradually hardens in the second year, if the plant be of a nature to develop into a tree or shrub, into what is termed woody fibre—to the consideration of which we propose to devote a brief portion of our space.

Cellular tissue and woody fibre.

Woody Fibre.

When we come to consider that this term is applicable not only to every species of timber, whether used by the builder, joiner, or cabinet-maker, but to every textile fabric woven of vegetal fibre, and even to paper, we shall perceive that its consideration opens a wide and important field of inquiry.

Textile fabrics.

Woody fibre, or lignine, differs but little, in its ultimate constitution, from starch and sugar. Like them, it is a ternary compound—that is to say, one containing three elements only, hydrogen, oxygen, and carbon, nitrogen being absent. Although woody fibre is absolutely identical in its structure, from whatever source obtained, yet in different trees it is found associated with a number of compound bodies giving a special character to the wood. Among these may be mentioned the resin or turpentine of the fir tribe, the astringent tannin of the oak, the sugar of the maple, etc. If lignine be subject to destructive distillation in a retort, as already stated, one of its constituents remains behind in the form of solid carbon; the others, while evolved in the form of gas, combine with the oxygen of the atmosphere to form new compounds, amongst which acetic acid and vegetable tar are the principal. The latter is a very complex body, susceptible of being resolved into paraffin, creosote, etc.

Lignine a ternary compound.

Compounds associated with lignine.

Vegetable tar.

Although exceedingly combustible, and still largely used as fuel in various parts of the world, woody fibre is nearly insoluble in water. We shall understand this when we remember that the textile fabrics woven from hemp, cotton, or flax, consist of woody fibre. If linen or cotton cloths were dissolved, or in any way impaired, by the action of water, it is evident that they would be practically useless. Gun-cotton is a singular example of the result of slow chemical action on lignine. We have already explained the method of the preparation of this singular explosive, and need only remark that the exact nature of the action of the nitric acid on the woody fibre is still unknown.

Woody fibre insoluble in water.

Gun-cotton.

All timber is subject to a certain slow process of destruction or decay, under circumstances unfavourable to its preservation, known as wet and dry rot. The former is a chemical decomposition of the wood effected by the combined action of air and moisture; the latter is attributable to the growth of an organic body on the substance of the wood—a species of fungoid vegetation. The arrest or prevention of decay in timber presents an important subject for the consideration of the chemist. Woody fibre, consisting as it does of an infinite number of small tubes, takes up moisture readily by capillary attraction; and although this property may tend to accelerate the decomposition of timber, yet it enables the chemist to inject certain substances, in a state of solution, into the substance of the wood, so as to render it less susceptible of decay. Timber is rendered yet more permeable to such solutions by being thoroughly dried, and by the exhaustion of the air in its capillaries.

Wet and dry rot in timber.

The preservation of timber.

Lignine has already been stated to be closely allied to starch and sugar in its chemical constitution. Sulphuric acid, if dropped upon a linen or cotton handkerchief, or even upon sawdust, will char or blacken it, as it does sugar. In point of fact, both starch and sugar may be developed from woody fibre, although the nutritious qualities of the starch thus prepared are very inferior to that of the same substance produced under normal conditions. We will now pass on to a consideration of this highly important and nutritious constituent of the substance of plants.

Ultimate constituents of lignine.

Starch from lignine.

Starch.

This substance is one of the principal constituents of wheaten flour, and indeed of every kind of farinaceous meal; and the nutritious properties of many vegetables depend largely upon the quantity of starch they contain. If we take a piece of crumb of bread, or better still a small quantity of flour, kneaded into a paste with water, we shall find that by enclosing it in a piece of rag and then squeezing or kneading it with the hand under water, a considerable portion of milky juice may be expressed, which, if left to settle, will gradually become clear, depositing the starch at the bottom of the vessel in which it is collected. That which remains behind in the cloth consists of another vegetable constituent—gluten. If a potato be reduced to a pulp by rasping, and the juice expressed from it, the turbid liquid thus obtained will in like manner be found to deposit a very considerable quantity of starch. The clear liquid from which the starch is deposited in every case contains a certain quantity of vegetable albumen.

Starch in vegetables.

Gluten.

Potato starch.

Albumen.

Dry starch presents to the eye the appearance of a fine meal. When viewed under the microscope, the different kinds of starch will be found to exhibit certain peculiarities of organic structure. The granules of starch, when boiled in water, swell prodigiously, and bursting, combine with the water to form a jelly-like compound. Arrowroot, sago, tapioca, are all substances containing a large proportion of starch. The nutritive value of such articles of food is, however, greatly enhanced by the presence of a small quantity of albumen.

Organic structure of starch.

Arrowroot, sago, etc.

The most interesting and valuable property of starch consists in the fact that it may be converted by chemical action into dextrine or gum and sugar.

Starch, for instance, may be changed into

gum by moderate heating with sulphuric acid, and by stronger heating into sugar. Starch, dextrine, and sugar may therefore chemically be regarded as modifications of the same group of elements, their difference consisting undoubtedly in a different arrangement of the ultimate atoms of carbon, hydrogen, and oxygen, of which they are composed. How the sulphuric acid operates to bring about this result, we are not at present enabled to state, as no portion of the sulphuric acid is decomposed in the process, nor has any of it entered into combination with the organic substance acted upon.

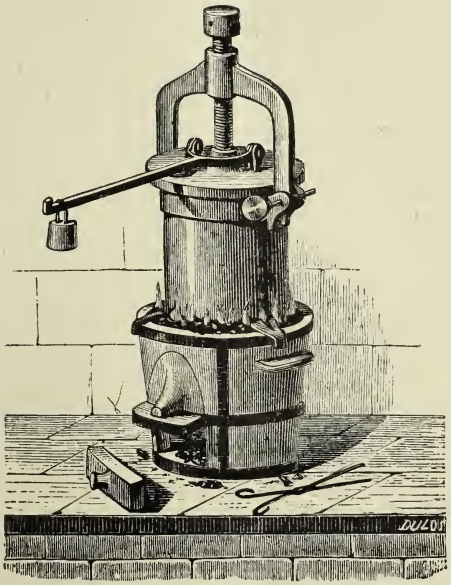
Action of sulphuric acid on starch.

Nature of its action unknown.

The process of brewing, and likewise that of the distillation of spirituous liquors from grain, are entirely dependent upon the fact that starch is susceptible of passing through these modifications, as the sugar thus obtained is, by a final chemical transformation, converted into alcohol. The medium whereby these changes are effected is not, however, any chemical agent, like sulphuric acid, but a natural compound developed in the grain in the process of malting, and termed diastase. Of this compound we know but little. It is developed in plants especially during the period of germination, and possesses the power of converting the starch of the grain or seed into dextrine and sugar. It is doubtless also produced, though probably in a less degree, by the processes of animal vitality. An example will suffice: if a piece of crumb of bread or a small quantity of wheaten flour be placed upon the tongue and kept for some time in the mouth pressed against the palate, it will be found to have acquired a distinctly sweetish taste, owing to the action on the starch of the diastase of the saliva. Of this compound, however, we shall have occasion to speak more fully under the head of brewing, before proceeding to do which we think it best to say a few words about that substance which is found to be developed by its action on starch—namely, sugar. Of the different kinds of sugar we shall take occasion to speak in the beginning of our next article, and we shall then briefly discuss the chemistry of the manufacture of that most useful and popular article.

Starch sugar.

Its existence in the saliva.



PAPIN'S DIGESTOR.

XXXVIII.

THE SYNTAX OF THE GENITIVE (*continued*).

The Subjective and Objective Genitive Case.

WE must now observe that the genitive, the case of the proprietor, generally defines nouns, either subjectively or objectively, according as the word put in the genitive case is the subject or object of the action or feeling. Thus, *consulis jussu*, by the consul's order, corresponds to *consul jussit*, where consul would be called the subject of the verb *jussit*. The objective genitive, on the other hand, is that where the genitive takes the place of what would be the object after the verb —as *cupido pecuniæ*, a passion for money, where the corresponding verbal phrase would be *cupere pecuniam*.

These two genitives often depend on one substantive — as *Helvetiorum injuriæ populi Romani*, the wrongs done by the Swiss to the people of Rome; where *Helvetiorum* is the subjective, *populi Romani* the objective, genitive.

(1) *The Subjective Genitive.*

A genitive of the author and possessor follows almost all substantives, and many verbs, especially *sum*, *facio*, *fio*—as *Polycleti signa*, the statues of Polycletus; *omnia quæ mulieris fuerunt viri fiunt*, all things which were the woman's become the husband's.

Observe that the possessive pronouns are used instead of the subjective genitive of the personal pronouns—as *pater meus*, my father, for *pater mei*, the father of me; and hence a genitive (subjective) may stand in apposition to a possessive pronoun, as in *Hi ad* VESTRAM OMNIUM *cædem Romæ restiterunt*, these remained at Rome with a view to the slaughter of you all (of all of you). In this way the relative may agree with a genitive implied in a possessive pronoun, as NOSTRA CÆDES, *qui remansissemus*, the slaughter of us who might remain behind.

(2) *The Objective Genitive.*

A genitive is joined objectively to substantives, adjectives, or participles which have a certain transitive force, especially if they

signify *skill*, *care*, *desire*, *anxiety*, or whatever is contrary to these—as *Insitus est mcnti cognitionis amor*, love of knowledge is implanted in the mind; *Avida est periculi virtus*, valour is greedy of danger.

The genitive is *objective* when it denotes that which is the object of the feeling or action or thought spoken of; but the genitive is *subjective* when it denotes that which does something or to which something belongs. Thus, in *Cæsaris sitis honoris*, Cæsar's thirst for honour, we have both an objective and subjective genitive case. *Cæsaris* is the subjective genitive case because it denotes the subject to whom the thirst belongs, as *who thirsts?* but *honoris* is the objective genitive because it denotes the object of the *thirst*.

Thus, too, in the phrases *hominum timor mortis*, men's fear of death, and *Ciceronis defensio Gabinii*, Cicero's defence of Gabinius, we have both the subjective and objective genitive cases combined. In one case *Ciceronis* is the subjective genitive case, as denoting the subject, and in the other *hominum* is the subjective genitive case, *mortis* and *Gabinii* being objective genitives, of *fear* in the one case and *defence* in the other.

The words which most frequently govern this double genitive are *amor*, love of; *odium*, hatred of; *cura*, anxiety for; *desiderium*, request for; *injuria*, injustice to; *miseratio*, *commiseratio*, compassion for; *obsequium*, respect to; *studium*, eagerness for; *fames*, hunger, and *sitis*, thirst for.

The objective genitive principally depends on words which contain the transitive form of the verbs from which they are derived—as *amor patriæ*, a love for one's own country; *cultus agrorum*, a cultivation of the fields; *scientia juris*, a knowledge of law; *ignorantia recti*, an ignorance of what is right; *cura peculii*, a care for property; *studium lucri*, a zealous seeking after gain; *sitis auri*, a thirst for gold; *remedium iræ*, a remedy or cure for anger; *luctus filii*, grief for his son; *suarum rerum fiducia*, confidence in her own affairs.

Observe that with the objective genitive case the genitive of the personal pronoun (*mei*, *tui*, *sui*, *nostri*, *vestri*), and *not the possessive pronoun adjective*, is used—as in *Misit filium non solum deprecatorem sui, sed etiam accusatorem mei*, He sent his son, not only to intercede for himself, but also to be the accuser of me. Our idiom would have required the use of the *possessive adjective:* his own intercessor and my accuser.

Exercises.

Translate into English :—

Memoriam amicorum mortuorum quàm maximè longam efficere debemus. Fortitudo est dolorum laborumque contemptio. Ex injuriâ Sabinarum mulierum hoc ingens atque atrox bellum ortum est. Pro veteribus Helvetiorum injuriis populi Romani. Cura Cæsaris patriæ est maximè admiranda. Noster amor Dei est summa virtus. Gratia beneficii est nobilissimi animi. Romanorum bellum Pyrrhi ad finem prosperum demum adductum fuit. Crescit amor nummi apud omnes nostros mercatores. Mors est longa quies laborum, et ultima fuga dolorum. Graves Cyclopum officinæ a nobis spectatæ sunt. Instar montis equus a Græcis militibus conditus est. Magna vis auri est in castris nostrorum hostium, id quod non omnes intelligunt.

Translate into Latin :—

Gratitude for a benefit is not a heavy weight to any good man. Grief for his sin is seen even in his countenance. A fear of the enemy has entered the breasts of our soldiers. The best of men are at times overcome (use *vincor*) with a feeling of compassion for the poor. Prayer and patience are the two best remedies against anger. How great is the hunger for gold, and the thirst for honour, in the minds of some men! The care of other people's affairs (translate by *res alienæ*) is not only difficult but burdensome. An escape from death is not possible to any man, for all men are mortal. The best of men cannot be without a care for their fellow-citizens. The love of country is no slight virtue. Cato's defence of the honour of his country was very noble, and will be always remembered in the grateful minds of his own countrymen the Romans. True fortitude is a just contempt for pain and toil in a just cause. Who forgets the wrongs done to the slaves?

Self-Examination Questions.

What is meant by an objective genitive case? What by a subjective genitive case? Are these two cases ever combined? Give instances. What kind of words are chiefly used with the objective genitive, and why? What words are chiefly found in connection with the double genitive, objective and subjective? Give instances. What pronoun is used, and which is not used, with the objective genitive case? Give examples.

The Genitive (Objective) with the Adjective.

Adjectives signifying *capacity*, *desire*, *experience*, *remembrance*, *participation*, *fulness*, and their opposites, govern a genitive case of the object—as *in omnes hominis hominem immemorem beneficii oderunt*, all men hated, and still do hate, a man that does not remember an act of kindness. Here observe that *beneficii* is the objective genitive case after *immemorem*, unmindful. Verbal adjectives in *ax* also take an objective genitive, as in *edax rerum est tempus*, time is the devourer of things. Here *rerum* is the objective genitive case after *edax*.

Many participles used as adjectives take the *objective* genitive, though when used purely as participles they give an accusative case, as do their verbs. Thus we have *patiens laborum*, patient under toils, where *patiens* is used as an adjective, and *laborum* is the objective genitive case after it; but *patiens labores* is suffering toils, as here *patiens* is the participle present of *patior*, to suffer. To this class of participle belong especially *diligens* and *appetens*—as in *Epaminondas adeo fuit* VERITATIS DILIGENS, *ut ne joco quidem mentiretur*, Epaminondas was so careful of truth that he would not utter a falsehood even in jest. Take, too, this sentence

from Sallust—*Alieni appetens, sui perfusus,* covetous of what belonged to others, but lavish of what belonged to himself. Observe in the first sentence *diligens* is used as an adjective, and governs the objective genitive case *veritatis;* if *diligens* were here a participle pure and simple, it would govern an *accusative case.* So in the second sentence, *appetens* as a participle would govern an accusative case; but here as an adjective it governs an objective genitive case.

The following adjectives govern an objective genitive case :—

Avarus, covetous; *rudis,* unskilled in or ignorant of; *avidus,* greedy of; *insolens,* arrogant, and unused to (observe that according to derivation *insolence* is the pride of a man whose head is turned by high position or great wealth, to which he has not been accustomed); *cupidus,* eager; *insolitus* and *insuetus,* unusual; *studiosus,* fond; *fastidiosus,* disdainful; *invidus,* jealous; *timidus* and *pavidus,* fearful; *liberalis,* liberal; *profusus,* lavish; *parcus,* stingy; *peritus,* skilled; *imperitus,* unskilled; *conscius,* conscious; *inscius, nescius,* ignorant; *præscius,* foreknowing; *gnarus,* knowing; *ignarus,* not knowing; *prudens,* foreseeing (deriv. from *pro videns*); *imprudens,* not foreseeing; *insolens, insolitus, insuetus,* unaccustomed; *compos,* master of; *impos,* not master; *potens,* powerful; *impavidus,* fearless; *memor,* mindful; *immemor,* unmindful; *curiosus,* careful; *incuriosus,* careless; *particeps,* participating; *consors,* sharing; *excors, expers,* not sharing; *inops,* weak; *plenus,* full; *inanis,* empty; *audax,* confident of; *edax,* devouring; *capax,* holding, capable of (used mentally and materially).

The genitive case follows nouns partitive, numeral adjectives, adjectives partitive, superlative, and comparative, as in *Primus regum Romanorum fuit Romulus,* Romulus was the first of the Roman kings, where *primus,* the numeral and superlative adjective, governs *regum* in the genitive case. Observe that the adjective always in such connections follows the gender of the noun in the genitive case, because that noun is really understood in a phrase which is really elliptical; for here observe that *primus regum Romanorum* is equal to *primus (rex) regum Romanorum,* the first (king) of Roman kings.

This partitive genitive is also found after adverbs of quantity, place, and time, when used *substantively,* as in *Satis* ELOQUENTIÆ, SAPIENTIÆ *parum,* enough of eloquence, (but) little of wisdom.

These adverbs which thus govern a genitive, and do duty for substantives, are *satis,* enough; *parum,* too little; *abunde* and *affatim,* abundantly; *ubi?* in what place? *eò,* to such a degree; *quò?* to what degree?

Exercises.

Translate into English :—

Ubi gentium nunc sumus, Quirites? Ille nunquam erat mentis compos, neque prudens rerum. Romani militis imperatorem laudabant, quippe qui sui esset profusus, et liberator omnium periculorum esset constans. Eò miseriæ fæmina redacta est. Bestiæ rationis et orationis omnino sunt expertes. Ejus pectus, ut aiunt, Bacchi plenum erat. Græcorum oratorum præstantissimus fuit Demosthenes, Romanorum Cicero. O maxime nostrorum poetarum, quid dulce carmen nobis contabis! Crœsus antiquorum regum erat multo opulentissimus. Ille est major juvenum, et planè ignarus artis militaris. Themistocles peritissimos belli navalis Athenienses fecit. Ira hominum semper impotens sui est. Omnes hominem immemorem beneficii rectè oderunt. Nostri melior pars animus est. Audax est ingenii hic poeta, qui dulcissima carminum nobis canit. Mens vatum (*bards or prophets*) est futuri præscia. Hic puer omnino est rudis belli et periculorum belli. Manuum fortior est dextra. Boni est nunquam officii esse negligens. Est natura hominum novitatis avida. Vive semper memor brevis ævi. Invidia edax pacis mentis semper erat. Virtutum in alia alius mavult excellere, neque stultorum quisquam beatus neque sapientium non beatus. Elephanto belluarum est nulla prudentior. Sulla, dux Romanus in hac ferè ultima pugnarum, centum viginti suorum amisit. Nunc est juvenum princeps, tunc erit senum princeps. Roma regionum Italiæ est media. Nemo mortalium omnibus horis sapit. Gallorum fortissimi sunt Belgæ.

Translate into Latin :—

The Indus is by far the largest of rivers. No general unskilled in the art of war, and without experience in battles, should be allowed to command an army. Care is the devourer of the mind. The soldiers of the general were eager for the fight. He is prodigal of others' property (*res alicuæ*), but sparing of his own. To such a pitch of misery are these soldiers reduced in time of war. None of these things which we see abide for ever. Thales was the wisest of the seven great philosophers. Plato was the most learned man of all Greece. The Romans became masters of great wealth. All anger is incapable of self-restraint (*continentia*). He is guiltless of his brother's blood. He never was sound in mind, or capable of managing his own affairs. Fame moves the mind eager for glory. He had no share in the plunder taken from the enemy in that fiercest of battles. How much of time does he spend on studies unproductive of any good! He was always most careless of little matters, but most careful of great matters. He is jealous of the fame of his fellow-soldier (*commilitis*). He is weak (or helpless) in mind, but skilled in letters. Sight is one of the most useful of the senses. Of the hands the right is the stronger. Seize his middle finger, which is the longest of all. Augustus was the greatest of Roman emperors.

Self-Examination Questions.

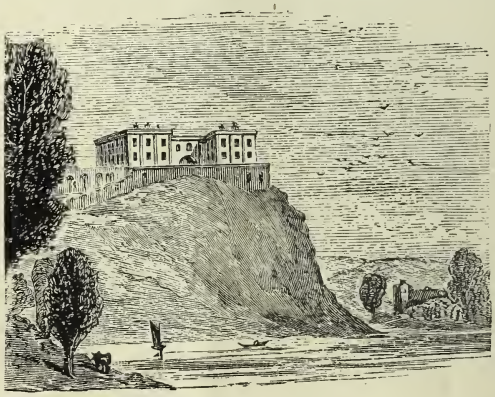
What kind of adjectives govern the genitive case? What kind of participles govern a genitive case? Give examples. Give a list of adjectives governing an objective genitive case, and account for such a government. What kind of adverbs govern a genitive case? Give examples. Account for the partitive genitive in nouns or adjectives, with examples.

XXXVIII.

Charles I. and the Long Parliament.

The Parliament, the calling of which we mentioned in our last article (*see* p. 335), was the famous Long Parliament, which sat at intervals during a period of nearly twenty years, and after undergoing the strangest vicissitudes of fortune, came to an end at last in 1660. The commons thoroughly understood their triumphant position, and were determined to strike at once, and heavily. Strafford, the inventor of the "Thorough," the evil counsellor of the king, who had advised the onslaught of a hired army as the remedy against the discontent of the nation, was the first upon whom vengeance was to fall. A very few days after the meeting of the houses he was impeached, arrested as he entered the house of lords with his hands full of papers, and conveyed at once to the Tower. About a month afterwards Laud was likewise arrested, and sent to the same place of durance. The different light in which the two men were regarded was forcibly illustrated by the further proceedings of the parliament with regard to them. Against Strafford the process was at once pressed forward, twenty-eight articles of accusation being exhibited against him,—a bill of attainder being passed to make his condemnation sure. Laud remained in prison for four years before the end came.

The Long Parliament.



NOTTINGHAM CASTLE.

Strafford's trial and execution.

Strafford defended himself with vigour and dignity; but his enemies considered themseives engaged in a life and death struggle, and would not hear of mercy, though the king only consented with the gravest reluctance to his death. "Put not your trust in princes," exclaimed the great earl bitterly, when he found that his master had signed his death-warrant. He was executed on Tower Hill on the 12th of May, 1641.

The first session of the Long Parliament was signalized by the sweeping away of a number of abuses. The Courts of Star Chamber and High Commission, and the Northern Court, were abolished. The prisons in which Prynne, Leighton, and the other puritan leaders had languished for years, were thrown open; and compensation was given, as far as possible, to those undaunted men for their sufferings. Some of the men who had acted as tools of tyranny during the last twelve years were punished; others, like Finch and Windebank, fled abroad for safety. Patents for life or during good behaviour were given to the judges. The most important act, as showing the extent of the popular victory, was the measure decreeing that the present parliament should not be dissolved without its own consent, and that in future at least every three years a parliament should be held.

Reform of abuses by the Parliament, and sweeping changes.

In August 1641 the king proceeded to Scotland, where a pacification was agreed upon episcopacy being abolished in that country. Hampden was at the same time despatched to Scotland by the house of commons as a commissioner to watch over the interests of the popular party, and especially to have an eye on the proceedings of the king. When, after a short recess, the parliament met again at the end of October, there came grave news of a terrible rebellion of the Catholics in Ireland, and the massacre of many thousands of Protestants, men, women, and children. O'Neill, the leader of the rebels, was taken and executed. The indulgence with which the Romanists had been treated by Charles, contrasted with the harsh measure dealt out to Protestant nonconformists,—together with the fact that the queen, who had great influence over him, belonged to that religion, and that Laud's church government had shown a tendency to approximate towards the Roman form,—roused a terrible suspicion of royal complicity in the minds of the puritan leaders in parliament, especially as O'Neill asserted he had received a commission from the king; and their first act on reassembling was the preparation of the Grand Remonstrance, in which the particulars of the misrule of the last twelve years were unsparingly set forth, to be presented to the king. On the other hand, a large party had arisen in the house of commons, including such prominent members as Hyde, Falkland, and Colepepper, who considered that the king, by acquiescing in the reforms of the last session, had atoned for past errors, and was entitled to a renewal of confidence. After a stormy debate of fourteen hours the Remonstrance was only passed by a small majority in the commons; and without being

The king in Scotland.

Irish rebellion.

The Grand Remonstrance.

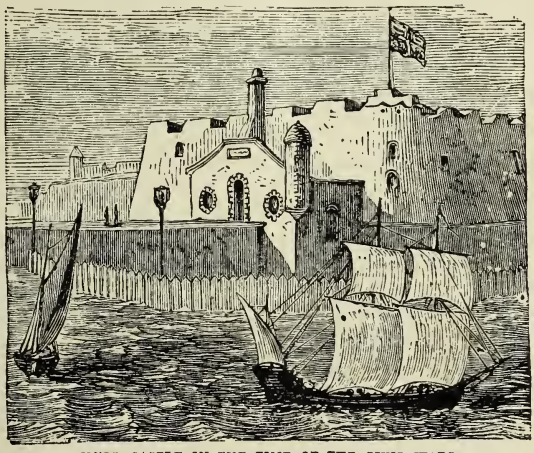
sent up to the lords, was presented to the king at Hampton Court.

The old feeling of loyalty that binds the English people to their rulers was evidently reviving, and the heart of the nation was turning again to its king, when he committed the most deplorable error of his ill-fated reign. A number of followers, composed chiefly of members of the inns of court, under a papist leader named Lunsford, had formed themselves into a kind of body-guard for the king, and had taken the name of Cavaliers. They had already been engaged in various conflicts with the cropped apprentices of the city, whom they contemptuously dubbed "Roundheads." These names afterwards were applied to the partisans of the king and of the popular cause respectively. On January 5th, 1642, Charles, having previously instructed his attorney-general to impeach Hampden, Pym, Hollis, Hazlerig, and Strode, five leading members of the opposition, at the bar of the lords, on a charge of high treason, proceeded to Westminster Hall, with a following of some hundred and fifty of this body-guard, and knocked for admittance at the door of the house of commons. He came to arrest the members in the house itself, in defiance of all law and right. They had received timely notice, and had just quitted the house, betaking themselves to the city, whose merchants and traders warmly sympathised with the popular cause. Charles saw that his intended stroke of violence had failed: "the birds had flown,"—and after a few muttered words on his respect for the rights of parliament, he rose and quitted the house, pursued by angry cries of "Privilege! privilege!" from the indignant members. The king then demanded the surrender of the members from the municipal authorities, and met with a distinct refusal. The house of commons, after adjourning for a few days, ordered the five members to attend in their places; and on the 11th, when the houses were to meet again, the city authorities determined to escort them back in triumph to Westminster. The king quitted London the day before the triumphal procession. The feeling in his favour had completely vanished, and the parliament had regained, through Charles's fatal error, the ascendency that had been seriously threatened only a few weeks before.

Reaction in favour of Charles.

Attempt to arrest five members, January 1642.

Excitement in the city.



HULL CASTLE IN THE TIME OF THE CIVIL WARS.

From York, whither he had retired, the king opened negotiations with the parliament, making some concessions, such as consenting to the exclusion of the bishops from the house of lords. But the point upon which the attempts at pacification failed was the important one of the command of the militia. The parliament would not trust the king with an armed force, lest he should employ it against the liberties of the nation; the king would not consent to give up the command of the militia; and the effect of this refusal was shown in the resolutions passed by parliament in June, to the effect "that the king, seduced by wicked counsels, intended to make war upon the parliament," and "that whosoever should assist him in such wars were traitors to the fundamental laws of the kingdom."

Charles at York; negotiations for compromise.

From the 22nd of August, 1642, the day on which the king, who had marched his army southward, unfurled the royal standard at Nottingham, the great civil war began. In this contest the king had on his side the majority of the nobility and the gentry, who rallied round him even when they most disapproved his proceedings; for to them he was "the Lord's anointed," whom to touch was sacrilege. The universities, too, were on his side—Oxford especially, the head-quarters of high church doctrine and cavalier students. The northern counties were generally in his favour, and the south-west part of the country furnished him with a small second army. The majority of the counties, however, were for the parliament, on whose side stood the bulk of the middle classes, the traders and merchants, and the great commercial towns with London at their head.

Personal animosity quickly embittered the strife between the Royalists and Parliamentarians. The cavaliers reviled their puritan opponents as a set of canting, hypocritical fanatics, straining at the gnat of Sunday sports, and swallowing the camel of rebellion, putting on a sour visage, discouraging all amusements, cutting down maypoles, and closing the theatres; and yet full of spiritual pride and self-seeking. Thus the cavaliers sang—

Cavaliers and Roundheads—mutual hatred.

> "They'll not allow, such pride it brings,
> No favours in hats, nor no such things;
> They'll convert all ribbons to Bible strings,
> Which nobody can deny."

To show their contempt for the canting Roundheads, they attired themselves in all the bravery of feathered hats and laced coats, wore their hair flowing over their shoulders, because the puritan clergy had written and preached against "the unloveliness of lovelocks"; and even shamed their cause by profanity and loose living, while upholding "Church and State." On the other hand, many of the Roundheads, with their cropped hair and sour faces, their tirades against cheerful and harmless pastimes, their affectation of scriptural language, and their continual sermons about "seeking the Lord," were too much like the false professors of religion afterwards described by Molière in his "Tartuffe"—"Qui font de dévotion métier et marchandise"—using the appearance of piety as a profitable stock-in-trade. Much sincere zeal and brilliant self-sacrifice there certainly was shown; but many grave faults were committed on both sides, and faults deepened into crimes as the struggle became more bitter.

The Cavaliers.

The Roundheads.

Of neither party could it be said that they had the monopoly of good intentions, and in both we find much to deplore as well as to admire.

The Earls of Essex and Bedford held the chief commands in the parliamentary army; and the most distinguished officers under them were Hampden, who raised a regiment in Buckinghamshire, Fairfax, Ireton, Waller, Pride, and the man who was destined to dominate them all, Oliver Cromwell. Lord Lindsey was in command of the king's troops, with Lord Falkland, the Marquis of Hertford, the Earl of Northumberland, Sir Marmaduke Langdale, and the two nephews of Charles, the sons of his sister Elizabeth the Palsgravine, the Princes Maurice and Rupert of the Rhine.

The armies and their leaders.

The first battle was fought at Edgehill, in Warwickshire. The conflict was undecisive, but it cost 4000 men, and put an end for a time to all hope of compromise; for it roused on both sides the passion of revenge, and numbers flocked to the respective camps of Royalists and Roundheads to take part in the deadly strife. From grange and manor-house brothers started; but their ways diverged at the first cross-road, and they never met except to kill each other in the opposing ranks. On the whole the advantage in the first campaign was on the side of the king. The sagacity of Cromwell quickly divined the reason. He pointed out to Hampden that the "decayed tapsters and serving-men" of the parliamentary army could not possibly be a match for the cavaliers animated by loyalty for the king's cause; and he accordingly brought against that loyalty the equally powerful incentive of religious zeal when he enlisted the Independents, the most respectable of the nonconforming sects, in the service of the parliament, and himself drilled and disciplined from among them that tremendous body of troopers known as Oliver's Ironsides.

Edgehill and its results.

Cromwell and the "Independents."

ALL IN GOOD ORDER.

BY THOMAS DUNMAN.

It has been well said, "Order is Heaven's first law." What a striking contrast there always is between the orderly and the disorderly household! Where the genius of order rules everything is in its place, and the eye is gratified and the mind soothed by the comfortable, cheerful appearance of the entire surroundings of the home. But where order is unknown the confusion irritates the mind, ruffles the temper, and intensifies the friction which, even in the best regulated homes, can never be altogether prevented. Human life is largely made up of trifles, and the sum of human happiness might be largely increased if these trifles were more carefully considered. For the greater portion of mankind life must always be comparatively uneventful, but for none need it be altogether monotonous or unendurable. The humblest student, the poorest workman, and the most plodding clerk, may each get a large amount of enjoyment out of life, and may be the means of conferring happiness upon himself and upon those around him, if he will but set the right way to work to attain this end; and in this attempt to get the most out of life an important factor is order or method.

We propose in this paper to briefly consider the best system to adopt in carrying on the business and pleasures of life in such a manner as to avoid as far as possible worry and anxiety.

Order, like charity, should begin at home. Young people have a grand opportunity of acquiring useful habits as soon as they get a room or a part of a house under their own control, and the manner in which they keep their domain is a certain indication of their personal character and habits. However small or humble the *sanctus sanctorum* may be, let it be kept well in order, be sure that there is "a place for everything" and that everything is in its place. The books, the writing materials, the nick-nacks, even the lumber, should be so bestowed as to give the bedroom or the study that appearance of neatness and comfort which is so suggestive of "home." Nor is it necessary to have grand or expensive furniture and effects to secure this. Every one has frequently seen very humble abodes look brighter and more comfortable than some of those where everything which wealth can purchase or fancy dictate has been present. The happiness of an individual does *not* consist in the abundance of the things which he possesses, but in the enjoyment he gets out of them, be they few or many. The well-kept room of an orderly person acts and re-acts upon its possessor, intensifying that love of order in which its arrangements originate. That which is called "taste" is, after all, only an intense love of order, and it may undoubtedly be easily acquired. We would therefore earnestly

counsel our readers to cultivate at home an orderly arrangement of their belongings, even to the veriest trifles, and the habit thus acquired will be found abundantly useful in the office, the workshop, the warehouse, the college, and in the world at large.

Next to the home, the most important object of consideration is undoubtedly *dress*. So much has been written, and not altogether without cause, about the sin and folly of studying too much the subject of dress and fashion, that there is a tendency on the part of some to fly to the opposite extreme. But this is altogether a mistake. Without doubt it is foolish and wrong to make the art of dressing well our sole study, to the exclusion of higher duties and obligations, but it does not follow that we are to be altogether careless as to our appearance, or that we are to offend good taste by dressing in an odd or antiquated fashion. Doubtless it is true that some great men have been very careless as to the matters of dress and appearance, but this has been an "*infirmity*," and not a healthy condition "of noble minds." It is the duty, as well as the privilege, of all to dress as well as their station and their pocket permit, and it is only when fashion is followed to absurd extremes, or when the money spent in dress exceeds that which our income justifies, that the habit of careful attention to appearance becomes a vice. We would therefore advise our readers to extend the same method and order which are adopted in their homes to their persons, and to be careful to dress in good taste and in a neat and orderly manner, thus avoiding the two extremes of over solicitude about dress, and of total neglect of its requirements.

But it is in the more important duties of life that there is the greatest scope for methodical and systematic habits. Many students waste energy and hopelessly fail in acquiring knowledge through the lack of a proper system of pursuing their studies. Flitting aimlessly from one subject to another, at one time studying with unabating energy and at another taking a long spell of complete idleness, they expend an amount of brain power to which the result attained bears no adequate proportion. To acquire knowledge it is necessary to pursue a methodical course of study—to have, as far as possible, a definite time allotted to each subject undertaken, to plod systematically on at each branch which it is desired to acquire, and to take necessary recreation at stated intervals. Above all things, in studying a subject, *never* "*skip*." It is a very common practice for students who are educating themselves to skip the difficult parts of a subject and attack only the easy ones. When a difficulty is encountered it is not mastered before proceeding further, but the student skips it, thinking to return to it later on. Such a proceeding is, however, a very foolish and illogical one, and will result in the acquirement of a smattering of knowledge in the place of sound information.

Method and order are also essential to the workman and to the man of business. Every transaction effected, every piece of work performed, must be done methodically and systematically, or it will be unsatisfactory, if not altogether unsuccessful. In business, as in every other walk of life, the amount of real, useful work depends very largely upon the methodical employment of energy. By keeping everything neat and orderly, by having a fixed time for every part of the routine of his daily work, the thoroughly business man may, without injury to health, and without unduly encroaching upon his leisure time, get through an amount of work which will astonish others as well as himself.

A direction in which there is room for a more methodical arrangement is that of eating and drinking. Students and men of business are especially liable to very unsettled and disorderly habits in this respect, getting their meals just how and when they can. To some extent this is often unavoidable, but it should be prevented as far as possible, or evil will sooner or later result. The human body is a wonderful machine, working, when in order, with marvellous regularity and exactitude. Not only do the beating of the heart and the movements of the chest partake of a rhythmical character, but many of the other functions of the body are performed in the same methodical way. To keep this machine in proper order, and to secure its efficient working, are, of course, the functions performed by food. It would, therefore, seem obvious that as the body wears and wastes rhythmically, it should be repaired in a similar manner. This conclusion is thoroughly borne out by the facts which come to the knowledge of the physician ; and it is perfectly certain that many a break-down in health, with all its consequent pain and inconvenience, has its foundation to a very large extent in irregular habits of taking nourishment. "Prevention is better than cure," and we warn our readers against allowing themselves to get into irregular habits in the matter of supplying the body with food.

Even in our recreations it is well to be methodical, and indeed the man who is orderly in business is almost sure to carry the same habits into his leisure hours. So much more may be got out of an amusement if it be methodically pursued, that it seems a pity to waste time in merely fugitive attempts at recreation. The daily constitutional is much more refreshing if it have an object, even though it be a trifling one ; and in our leisure hours we may frequently turn our time to useful account, without in the least allowing the occupation to become work. Some may take to gardening, others to boating and cricket, and others again to mechanical employment ; but whatever the form of recreation indulged in, it is much more pleasurable if it have a definite object.

Finally, we would counsel our readers to bear in mind that a methodical discharge of the duties of life will result in benefit to themselves as well as to those around them. In the freedom from worry and anxiety, in the evenness of temper and in the absence of self-reproach which the due discharge of duties and responsibilities will ensure, the methodical and orderly individual will reap a rich and sure reward.

ELECTRICITY AND MAGNETISM.

XII.

VOLTAIC ELECTRICITY (*continued*).

BY means of a delicate condensing electroscope it may be shown that the two plates of metal, referred to in the close of our last article (*see* p. 329), as soon as they are immersed in the liquid, and before they are connected with each other, assume opposite electric conditions, the zinc exhibiting a feeble charge of *negative* electricity, the copper a similarly feeble charge of *positive*. Here, then, we have one proof of the identity of the two electricities, inasmuch as both affect the gold-leaf electroscope in the same way.

Another proof may be obtained as follows. Take your cell and stand it so that the wire connecting the plates shall be in a north and south direction. Now bring near the wire a magnetic needle. It will be found that the needle is deflected from its normal position. Again, if an ordinary sewing needle or any similar piece of steel be laid above and across the connecting wire, it will be found after a short time that the needle has become magnetised. It will be found, moreover, that, as in our diagram, fig. 42, the end A of the needle will point to the north, but if the wire C be connected with the copper plate instead of the zinc, so that the current flows in the opposite direction, as in fig. 43, the end B will point to the north.

To both these facts parallels may be obtained by means of frictional electricity. For instance, if we take a long coil of silk- or cotton-covered wire, and place in it an "astatic" needle, as in fig 41, the needle will be deflected, when a series of sparks from the prime conductor of a machine is passed through the coil.

Parallel effects with frictional electricity

Again, if a needle or similar piece of steel be laid upon and across a piece of tin-foil, and a series of sparks be passed through the foil to the earth, the needle will after a time become magnetized; and moreover, if the direction of the current be reversed, the polarity of the needle will also be reversed.

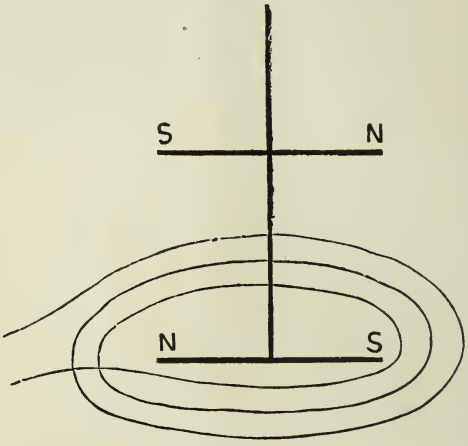


FIG. 41.

Here then we have evident traces of agreement between the electricity of the machine and the electricity obtained from a galvanic battery, yet at the same time we have evidences that there are some differences in the nature of their manifestation. In point of fact, the two electricities differ in quality, though they are the same in kind.

As we have before seen, the electricity obtained by friction is produced in a very concentrated form. It can leap across very considerable intervals, and a brilliant spark may be obtained from the most simple apparatus. As we say, its *tension* is very high, and hence this electricity is sometimes spoken of as *high tension* electricity. On the other hand, the electricity obtained even from a considerable galvanic battery cannot pass across the most trifling interval, but at once ceases if the wires from the poles be but the most minute fraction of an inch apart. Its *tension* we say is very low, and consequently it is often spoken of as *low tension* electricity.

Differences in quality.

When, however, we come to take into account

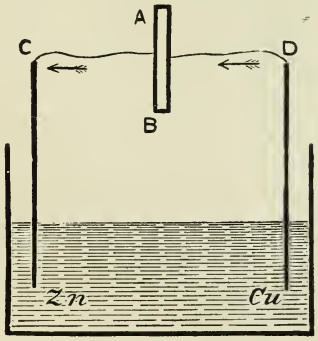


FIG. 42.

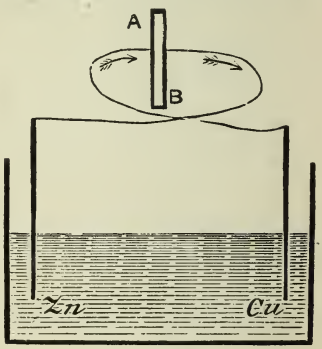


FIG. 43.

the quantity of electricity produced by the two methods in question, we find that that produced by chemical action vastly exceeds in quantity that produced by friction. It is only with extreme difficulty and with powerful apparatus that frictional electricity can be made to decompose water into its two gaseous elements, hydrogen and oxygen, while, as we shall presently show, this same decomposition can be readily performed with two small galvanic cells.

Differences in quantity.

We may say, therefore, in summing up the distinctive features of the two electricities, that that of the machine has a very *high* quality or tension, but is comparatively small in quantity; while that of the galvanic battery is produced in very considerable quantity, but is of a very *low* quality or tension.

To give an idea of these differences, we may mention the following facts observed by Faraday. He found that when two wires, each $\frac{1}{3}$th of an inch in diameter, were immersed for $\frac{4}{8}$ths of an inch in a cell of acidulated water for $\frac{3}{20}$ths of a second, a greater effect was produced upon a magnetic needle than by the electricity generated by 28 turns of the large electric machine of the Royal Institution. He also found that the quantity of electricity disengaged by the decomposition of a single grain of water was equal to that liberated in 800,000 discharges of the great Leyden battery of the Royal Institution; while he estimated the electricity produced by the chemical action of a single grain of water upon four grains of zinc to be equal in quantity to that of a powerful thunderstorm.

Observations of Faraday.

Having seen the nature of the connection which exists between frictional and voltaic electricity, we can now return to a consideration of the *rationale* of the method by which the latter is produced.

We have seen that when a a plate of zinc and a plate of copper are placed in dilute sulphuric acid or brine they assume opposite electrical conditions; and we have seen further that when the two plates are brought into contact with each other, or, better, are united by a wire, certain changes take place in the liquid and in the wire which indicate the presence of electricity. We see the bubbles of gas on the copper plate; we find that the zinc plate is gradually being eaten away; we find that a magnetic needle placed over or under the wire is deflected from its normal position; we find that the wire is slightly heated, and that it is capable of attracting iron filings; and we find, moreover, that all these effects instantly cease when either the wire is broken or one of the plates is lifted from the liquid. Now, we are unfortunately totally ignorant at present as to the ultimate cause of all these phenomena, but they almost irresistibly suggest to us that something is passing along the wire and through the liquid; and that something, because it appears as it were to *flow* through the system, we, for want of a better name, term an *electric current*.

Changes in the voltaic cell.

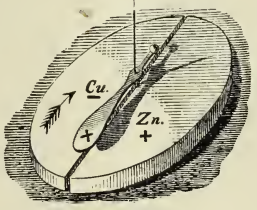


FIG. 44.

Moreover, we, for purposes of convenience, determine to consider the course of this current as being *from* the copper *to* the zinc in the wire, and *from* the zinc *to* the copper in the liquid. It must, however, be perfectly understood that the actual *flow* of electricity is not a proven fact, but, like the direction in which it is supposed to flow, only a very convenient theoretical convention. A change in the condition of the connecting wire the facts observed abundantly testify, but as to what is the exact nature of that change of condition nothing has as yet been satisfactorily ascertained.

Before leaving this part of our subject, it will be well to mention one or two experiments which tend to confirm the truth of the so-called "contact theory" of the origin of the electric current. As we have already mentioned, it is assumed by the defenders of this theory that the mere contact of two dissimilar metals causes them to assume opposite electrical conditions, and that the metals thus touching are maintained in these opposite electrical states. In proof of these suppositions the following experiments are adduced.

Proof contacts of theory.

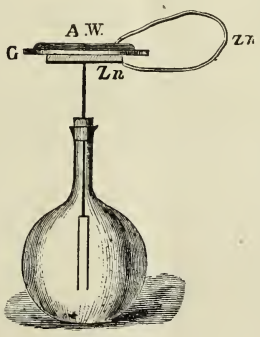


FIG. 45.

If, as in fig. 44, a positively charged needle, N, be suspended over the line of junction of two semicircular plates of zinc and copper, the needle will turn towards the copper, as shown in the diagram by the arrow; proving that the copper must be negatively and the zinc positively electrified.

Again, if, as in fig. 46, a small bar of copper, *b*, be soldered to a similar bar of zinc, *a*, and the latter being held in the hand, the compound bar be brought into contact with the lower unvarnished plate of the condensing electroscope, while the finger is placed upon the upper unvarnished plate of the condenser, it will be found, upon removing the bar and the finger, and subsequently raising the plate of the condenser, the leaves diverge with (as may be proved in the usual way), negative electricity. Here positive electricity must accumulate on the upper and negative upon the lower plate of the electroscope. If the compound bar be reversed, so that the copper end is held in the hand, it will be found upon proceeding as before that the leaves of

the electroscope become charged with positive electricity. If, however, the end of the bar held in the hand be protected by an insulator, as flannel, no electricity is produced, even though the end be connected with the earth or with the upper plate of the condenser by a wire.

Now, there are two ways of looking at this latter experiment. The opponents of the contact theory assert (and it would seem that they are correct in doing so) that the development of electricity here is due to the chemical action of the saline perspiration of the hand upon the zinc or copper, as the case may be. On the other hand, the supporters of the contact theory, while they admit the chemical action between the moisture of the hand and the metal, regard the perspiration merely as a conductor which undergoes decomposition, and in the second case explain the non-accumulation of electricity as due to the equal and opposite current which is, they say, set up between the condenser and the zinc.

Explanation of last experiment.

With regard to the first experiment, which seems at first sight most conclusively to support the contact theory, it is argued by the opponents of that theory that the oxygen and moisture of the air so act upon the discs of zinc and copper as to corrode the zinc and form what is really a very feeble galvanic cell.

In our diagram, fig. 45, p. 361, we have represented an experiment designed to illustrate the production of electricity by the action of a single liquid upon a single metal. To an ordinary gold-leaf electroscope a zinc plate, Z*n*, is attached, and to this a narrow strip of zinc, z*n*, is soldered at one end, the other being left free. Upon the zinc plate is placed a very thin, dry, varnished glass plate, G, and upon this again a little water, A W, acidulated with sulphuric acid. The free end of the zinc strip z*n* is then brought into contact with the acidulated water, and upon lifting the glass plate, G, the leaves of the electroscope diverge with negative electricity. Positive electricity must therefore have accumulated in the acidulated water.

Electricity from a single metal.

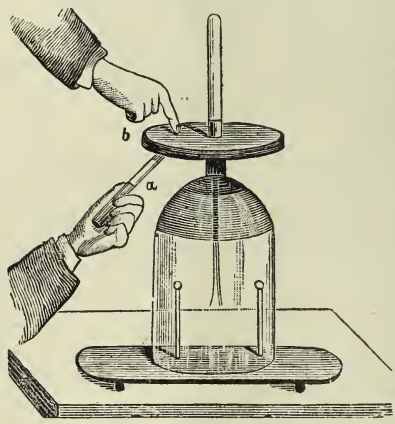


FIG. 46.

If copper be substituted for the zinc, both in the plate and in the strip z*n*, a negative charge is still given to the leaves of the electroscope; but it is of a feebler character than the charge obtained when zinc is employed in the experiment.

In our next article we shall return to speak of the acidulated water and metal plates of the voltaic cell, and try to give some explanation of the production of electricity by their means.

POLITICAL GEOGRAPHY.

IV.

FRANCE.

FRANCE, a large and important country of western Europe, is situated between lat. 42° 20′ and 51° 5′ N. and long. 4° 45′ W. and 7° 45′ E., and is bounded on the north-west by the English Channel, separating it from Britain; west by the Atlantic Ocean; south-west by the Pyrenees, separating it from Spain; south-east by the Mediterranean; east by Italy, Switzerland, and Alsace, from which it is separated by the Alps, the Jura mountains, and the Vosges; and north-east by the German portion of Lorraine and Belgium. It is somewhat hexagonal in form, and measures from north-west to south-east 680 miles, and from north-east to south-west 620. Area 204,000 square miles. Population (1876), 36,905,784, of whom 98 per cent. were Roman Catholics and 1·6 per cent. Protestants; the Jews numbered about 50,000. Its boundaries are mostly natural, except on the north-east. The coast-line measures about 1480 miles, of which 560 are on the English Channel, about the same number on the Atlantic, and 360 on the Mediterranean. The coasts on the English Channel are generally bordered by sandy downs. The west coast is at first elevated, bold, and rocky, but it gradually declines as it proceeds south, and from the mouth of the Gironde it presents an unbroken line of sandy downs interspersed with marshes.

The surface is mostly level, with here and there low ranges of hills, except on the south and east, where the frontier mountain ranges send forth offsets towards the interior. The loftiest summit of the Alps in France is Mont Pelvoux (14,108 feet), and of the Pyrenees Mont Perdu (10,990 feet). The Cevennes range is separated from the Pyrenees by the valley through which the Canal-du-Midi passes, and extends first in a north-north-east and afterwards in a northern direction for about 360 miles. It takes various names during its course, and has an average height of 3000 feet, the highest summit being Mont Mexen (5795 feet). It forms the watershed of the country between the Mediterranean and the Atlantic. The mountains of Auvergne, a branch of the Cevennes, have their loftiest point (Puy de Sancy) 6180 feet. The Côte d'Or range and the heights of Langres connect the Cevennes with the Vosges.

The principal rivers of France are the Garonne, Loire, Seine, and Rhone. The Garonne rises in the Pyrenees, flows first north, then north-west, till it falls into the Bay of Biscay by the estuary of the Gironde. The Loire, the longest river of France, rises in the Cevennes, and after a course of 560 miles, first northward and then westward, through the centre of the country, falls into the Bay of Biscay. The Seine rises in the department of Côte d'Or, has a winding course of 450 miles, generally in a westerly and north-westerly direction, and falls into the English Channel. The Rhone rises in the mountains of Switzerland, and after passing through the lake of Geneva, enters France, and flows almost due south to the Mediterranean, which it enters by several mouths. Its principal tributary is the Saône. The chief of the other rivers are the Moselle, Meuse, Scheldt, Somme, Charente, Dordogne, Adour, Aube, Herault. France possesses in all about 5500 miles of river navigation, besides about 3000 miles of navigable canals. The principal canals are the Canal-du-Midi, which connects the Atlantic with the Mediterranean by means of the Garonne; the Canal-du-Centre, which unites the Saône and the Loire; and the Marne-Rhine Canal, which joins the Seine and the Rhine. The roads of France are generally excellent; and there are in all about 15,000 miles of railway.

The climate differs considerably in different parts. In the north it bears a marked resemblance to that of the south of England, but the winters are frequently long and rigorous. In the centre the climate is more mild and steady, and in the south it resembles that of Spain and Italy, the summers being long and warm, the winters of short duration, and the sky almost always serene. In general the climate of France is dry, pleasant, and healthy.

About one-eighth of the surface is covered with wood. The principal forests are those of Ardennes, Compiègne, Fontainebleau, and Orleans, consisting chiefly of oak, birch, pine, beech, ash, elm, and chestnut. Agriculture is in a very backward state, and the implements in use of an inferior description, owing to the minute subdivision of the land. The chief crops are wheat, barley, rye, maize, oats, potatoes, beetroot for the manufacture of sugar, flax, hemp, etc. The vine is cultivated to a very great extent, and the wines of Bordeaux. Burgundy, and Champagne, are well known, Fruit trees abound, as apple, pear, chestnut, walnut, fig, plum, almond, olive, orange, citron, pomegranate. The mineral wealth of the country is great, and includes coal, iron, copper, lead, silver, and antimony. The chief manufactures are woollen, linen, cotton, and silk stuffs, iron and steel wares, cabinet work, porcelain, glass, jewellery, watches, sugar. The principal imports are raw cotton and silk, flax, wool, coal, iron, and colonial produce; exports, wine, brandy, oils, fruits, silk and woollen stuffs, linen, lace, and fancy articles. In 1880 the total value of the imports was £196,300,000, of the exports £136,025,000. In 1879 the imports from the United Kingdom into France amounted to £23,960,000, and the exports from France into the United Kingdom to £33,208,000. The foreign possessions of France have an area of 348,000 square miles, and a population of 8,525,000.

The government of France is a republic, the legislative power being vested in two assemblies —the chamber of deputies and the senate. The members of the former are chosen by universal suffrage; of the latter, which is composed of 300 members, 225 are chosen by the different departments and the colonies, and 75 by the national assembly, which is formed of the members of both assemblies. The president of the republic is chosen by the majority of votes of the national assembly for seven years. In him the executive is vested, and his ministers are responsible for his actions, he himself being answerable only for high treason. The ordinary revenue for 1882 is estimated at £114.261,408. and the expenditure £114,169,316. The public debt under various forms amounts to £940,000,000. Military service is compulsory, and all capable of bearing arms are liable to serve five years in the regular army and fifteen years in reserves. The regular army numbers 495,880 men, and the navy 356 vessels of war of all kinds, with 1504 officers and 41,237 men.

Before the revolution of 1789, France was divided into 33 provinces. It is now divided into 86 departments, each of which is usually named after its principal river, mountain, or other natural feature. Each department is subdivided into arrondissements, cantons, and communes. The French as a people are distinguished for their gaiety and love of pleasure, fickleness of disposition, and love of military glory, as well as for their exquisite taste and courtesy. In literature and science they have many distinguished names. The system of education is national, and is presided over by a minister of state. The capital, Paris, is the largest city in Europe after London, and had in 1876, 1,988,806 inhabitants. Next come Lyons (342,815), Marseilles (318,868), Bordeaux (215,140), and Lille (162,775).

XXXVII.

SATURN.

FROM its unique system of rings, Saturn presents some of the finest phenomena visible in the entire solar system. These rings which encircle it, by their continual variation as the planet in its motion in its orbit causes us to view them more or less obliquely, give a wide variety to the appearance of Saturn, and in conjunction with the phenomena presented by the eight rapidly moving satellites, renders the planet a most striking object. As the principal features of the Saturnian system can be seen with even small telescopes, this planet

is generally one of the most interesting bodies for those with only moderate instruments ; and as for the next fifteen years it will be favourably placed for observation, much will doubtlessly be learnt of the telescopic appearance of the planet, and in consequence of its probable physical condition.

The planet itself, or rather its ball as it is called, does not show much to even the most attentive telescopic scrutiny: all that can be detected are some faint equatorial greyish belts on the golden-yellow disc—indications of a physical condition somewhat similar to that of Jupiter—but the faintness of these belts would indicate that Saturn was still more buried in dense clouds than even its giant neighbour.

Figure and dimensions.

In figure, Saturn is the most spheroidal of all the planets, its ellipticity being about $1 \div 11$, the planet when at its mean distance from the earth having a polar diameter of 15·4″, and an equatorial diameter of 17·0″, its mean diameter being about 16·5″. In the telescope, owing to the irradiation, these quantities seem about 0·8″ larger. From these dimensions it would appear that the actual diameter of Saturn would be 73,000 miles, 66,000 miles, and 71,000 miles respectively, so that the mean diameter is about nine times as large as that of the earth, and its volume would be about 700 times as large. As the mass of Saturn, which is easily determined from the motion of its satellites, is $1 \div 3500$ of the sun, or only rather more than 90 times that of the earth, it follows that the mean density of the planet can be only one-eighth of that of the earth or three-fourths of that of water. This would almost seem to indicate a very high temperature—even higher than that of Jupiter—though as probably the older and certainly the smaller planet, this is not what we should have expected. Saturn rotates on an axis inclined at an angle of 26° 50′ to its orbit, or 28° 50′ to the plane of the ecliptic, once in 10 h. 14 m. 29 s. This determination, however, is very uncertain, for there are few well-marked spots visible from which to determine the true period of rotation.

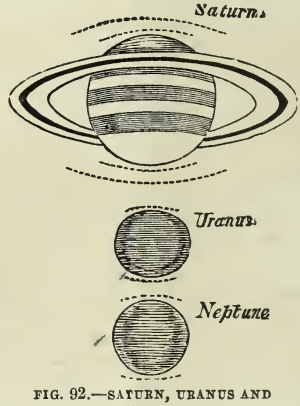


FIG. 92.—SATURN, URANUS AND NEPTUNE.

The magnificent ring system of Saturn consists of three broad flat rings of very slight thickness, and slightly elliptical in form, rotating once in about 10 h. 29 m. round the planet, which lies in one of the foci of the rings; the whole system being in nearly the same plane as the equator of Saturn. The outermost ring has an apparent telescopic diameter of 39·9″, or a real diameter of about 39·4″ or 169,500 miles. It is separated from the brighter inner ring by a dark division, about 1″ wide, named after its discoverer *Ball's division*. Its outer diameter is 34·4″ or 144,600 miles, its inner 26·3″ or 123,000 miles. It is brightest at its outer edge, and gradually fades away at its inner edge. In both these rings astronomers have observed a number of fine consecutive black markings, dividing as it were each ring into a number of small rings ; but it is difficult to say how far these apparent divisions are real. The innermost or dusky ring is much fainter than either of the others, and is partially transparent, so that the limb of Saturn can be perceived faintly through it. Its inner edge is distant about 2″ from the edge of the ball, so that its inner diameter is 21·0″ or 100,000 miles. The thickness of the ring is less than 0·1″ or 400 miles. Many speculations have been hazarded as to the probable nature of these rings, but it would seem most probable that they are zones of minute satellites, perhaps fifty miles in diameter, and separated from each other by six or seven times this distance in the brighter rings, and rather more in the dusky ring. These satellites would not unlikely be surrounded by considerable atmospheres, which, joining one another, would cause the entire rings to be enveloped in a gaseous medium, which might be the source of many of the variations in brightness which have been noticed in the rings.

Rings.

The mass of the rings is probably less than one five-hundredth of the mass of the planet itself. The plane of the rings makes an angle of 28° 10·6′ with the plane of the ecliptic, and its ascending node is in longitude 167° 55′ at the present time (1882).

Saturn has at least eight satellites, seven of which move in orbits in the same plane as the rings, whilst the most distant moves in an orbit much inclined to the plane of motion of the others. The names, distances in radii of Saturn, and periods of these satellites, are as follows :—

Satellites.

			d.	h.	s.	m.
1. Mimas	Distance 3·36	Period =		22	37	23
2. Enceladus	,, 4·32	,, =	1	8	53	7
3. Tethys	,, 5·34	,, =	1	21	18	26
4. Dione	,, 6·84	,, =	2	17	41	9
5. Rhea	,, 9·55	,, =	4	12	25	11
6. Titan	,, 22·15	,, =	15	22	41	25
7. Hyperion	,, 26·78	,, =	21	7	7	40
8. Iapetus	,, 64·36	,, =	79	0	8	36

The innermost of these satellites, *Mimas*, moves in an orbit so close to the planet that it never moves very far from the rings, and owing to its proximity to these bright objects can only be seen with great difficulty, though it probably is bright enough to shine like a 12th standard magnitude star. Its diameter is therefore about 600 miles, or less than half of the smallest satellite of Jupiter. *Enceladus*, from its greater distance from the planet, is far easier to see, though it is probably but little larger or brighter than Mimas. *Tethys* would seem to be considerably larger than either of the inner satellites.—probably about 1000 miles,—so that it shines like a star of about the 11th magnitude, and

from its distance from the planet can be readily seen in telescopes of moderate aperture, four inches being ample on favourable occasions. *Dione* and *Rhea* are still brighter, shining like stars of the 10½th and 10th magnitude, and are readily visible in even small telescopes; they are about 1300 and 1400 miles in diameter, or about the size of the smaller satellites of Jupiter. *Titan* shines like a star of the 8th magnitude, and is probably 3500 miles in diameter—considerably larger than even the III satellite of Jupiter, and approaching Mars in dimensions. *Iapetus* is probably little inferior to Titan in size, but is not so bright; it is moreover very variable in brightness—at times, when in the western portion of its orbit, shining like a star of the 8½th magnitude, and at other parts of its orbit fading away till only of the 11th magnitude. It moves, too, in an orbit inclined at an angle of nearly 12° to the plane of the orbits of the other satellites. Between these two larger satellites, but much nearer Titan, comes *Hyperion*, a minute satellite shining like a star of the 13½th magnitude, and probably only 300 miles in diameter, so that it can only be seen in powerful telescopes, at least eight inches aperture being required.

It is not unlikely that there are other small satellites in the great gap between Titan and Iapetus, and not improbably also between Rhea and Titan. If so, they cannot be much larger than Hyperion, and are most likely even smaller, or between 200 and 400 miles. From their considerable distance from the planet and extreme faintness, these bodies would not be readily detected, and no systematic search seems to have been made. From the strange discordance in the observations of Hyperion, it is not unlikely that at times another similar satellite may have been seen and mistaken for this body. There may also be satellites interior to Mimas, but if so their proximity to the planet would render it excessively difficult to see them even in the finest telescope; still if the rings are really great groups of small satellites, it is not unlikely that one or more of such bodies may really exist and yet be detected.

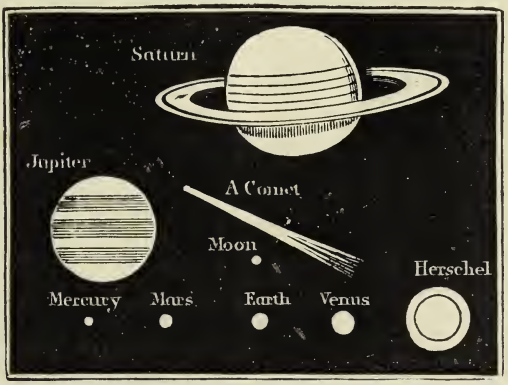


FIG. 93.—RELATIVE SIZES OF THE PLANETS.

URANUS.

Owing to its great distance from the earth, very little can be made out on Uranus, even in the most powerful telescopes: some observers have indeed fancied that they could detect very faint bands and spots, but it is difficult to say how far they are imaginary. Probably the planet is spheroidal in form, but the amount has not yet been determined with any certainty, nor even the exact position of its poles, though the approximate direction of its axis is ascertained by assuming that it is at right angles to the plane of the motion of its satellites.

It is supposed, therefore, that the axis of Uranus is inclined at an angle of 97·8° to the ecliptic, and that the ascending node of its equator is in longitude 165·5°, whilst its axial rotation is probably about 12 h.

The telescopic diameter of Uranus is about 3·8″, which would correspond to a real diameter of about 3·3″—that is, to 28,500 miles, or about three and a half times that of the earth, so that its volume would be rather more than forty times as large. From the motion of its satellites, it would appear that its mass is only 1 ÷ 23,000 times that of the sun, or fourteen times greater than that of the earth; so that the mean density of Uranus would be only one-third of the mean density of the earth, or rather less than twice that of water. It is probable that the physical condition of the planet resembles in all essential characters that of Jupiter. **Dimensions.**

The great inclination of its axis of rotation, if it be really perpendicular to the plane of the orbit of its satellites, will, however, give rise to enormous seasonal changes, since the duration of both day and night must vary in length from only a few hours to many years, as the planet moves in its orbit. The influence of such variations must be very great.

Uranus possesses four satellites, whose names, distances in mean radii of Uranus, and periods, are :— **Satellites.**

				d.	h.	m.
I. Ariel	Distance 7·2 = 13″·8	Period	=	2	12	28·8
II. Umbriel	,, 11·5 = 19·2	,,	=	4	3	27·6
III. Titania	,, 18·9 = 31·5	,,	=	8	16	56·4
IV. Oberon	,, 25·3 = 42·1	,,	=	13	11	6·6

The two outer satellites are not very difficult to see, being about 12½ magnitude (standard), but owing to their proximity to the planet appear about half a magnitude fainter. Under favourable circumstances they can be easily seen with telescopes of about nine inches aperture. They are probably about 2000 miles in diameter. The two inner satellites are much fainter, probably not brighter than 14th magnitude, and very difficult to see, as they are never far from the planet. Their real diameter is probably less than 1000 miles.

NEPTUNE.

The history of the discovery of this planet has been already narrated, and since its discovery nothing new has been made out about either the form, **Dimensions.**

dimensions, or physical condition of the planet, as its distance renders it a minute faint object even in the largest telescopes. Its apparent diameter at its mean distance would seem to be about 2·6″, which would correspond to a real diameter of some 2·0″ or 27,000 miles. The mass of the planet, which is the only factor determined with certainty, is $1 \div 19{,}000$ of that of the sun; so that in density, as in dimensions, it is closely analogous to Uranus.

Satellites.

The only satellite of Neptune which has yet been discovered moves round the planet once in 5 days 21 hours 3·0 minutes, at a mean distance of 8·1 radii of the planet, or 16·2″. Like the satellites of Uranus, its orbit is inclined at more than a right angle to the ecliptic, the inclination being equal to 145·1° and the longitude of the node being 184·5°. In brightness it shines like a standard 12th-magnitude star, so that its size must be very considerable, probably over 6,000 miles in diameter. It is therefore the largest body of its class, and in dimensions resembles the inner planets of the solar system—being larger than Mars, and not much smaller than Venus. It is not unlikely that there are other satellites as yet undiscovered.

XXXVIII.

Simple Interest (*continued*).

III. *Given the interest, the rate, and the principal, find the time for which the principal is lent.*

The time is evidently equal to the quotient arising from dividing the whole interest by the interest for 1 year;

and interest for 1 year $= \dfrac{\text{principal} \times \text{rate}}{100}$.

Example (1).—Find the time for which £500 must be lent at 7 per cent. so as to produce £166 5*s.*

Interest for 1 year $= \dfrac{£500 \times 7}{100} = £35$

$\therefore$ time $= £166\ 5s. \div £35 = \dfrac{166\frac{1}{4}}{35} = 4\frac{3}{4}$.

Example (2).—Find in what time £429 3*s.* 4*d.* will *amount* to £472 1*s.* 8*d.* at $2\frac{1}{2}$ per cent.

Int. for required no. of years = Amount − Ppal.
$= £42\ 18s.\ 4d.$

Int. for 1 year $= \dfrac{£429\ 3s.\ 4d. \times 2\frac{1}{2}}{100}$

Required time $= \dfrac{\text{given interest for that time}}{\text{interest for 1 year.}}$

$= \dfrac{£42\ 18s.\ 4d. \times 100}{£429\ 3s.\ 4d. \times 2\frac{1}{2}} = \dfrac{42\frac{11}{12} \times 100}{429\frac{1}{6} \times 2\frac{1}{2}}$

$= 4$. Ans. 4 years.

IV. *Given the interest or the amount, the rate, and the time, find the principal.*

(1) Suppose the *interest* to be given.

If we divide the given interest by the given time (expressed in years), we get the interest for 1 year.

Then clearly $\dfrac{\text{interest on ppal. for 1 year}}{\text{interest on £100 for 1 year}} = \dfrac{\text{ppal.}}{£100}$

$\therefore$ ppal. $= £\dfrac{\text{interest on ppal. for 1 year}}{\text{rate per cent.}} \times 100$.

Example.—Find what principal will produce £36 interest in 4 years 6 months at the rate of $2\frac{1}{2}$ per cent.

Interest for 1 year $= £\dfrac{36}{4\frac{1}{2}} = £8$.

Now, interest for 1 year on £100 : interest for 1 year on required principal : : £100 : required principal,

or £$2\frac{1}{2}$: £8 : : £100 : required principal;

$\therefore$ required principal $= £\dfrac{8 \times 100}{2\frac{1}{2}} = £320$.

(2) Suppose the *amount* is given.

Find the amount of £100 for the given time; then, as the amount is proportional to the principal which produces it, we have

Amount of £100 : given amount : : £100 : required principal.

Example.—Find principal which amounts to £8320 in 4 years at 8 per cent.

Amount of £100 in 4 years $= £100 + 4 \times 8 = £132$

$\therefore$ £132 : £8320 : : £100 : required principal

$\therefore$ required ppal. $= £\dfrac{8320 \times 100}{132} = £6303\ 0s.\ 7\frac{3}{11}d.$

To find the interest when the time is expressed in years and months, we may conveniently use the method of aliquot parts, as in Practice.

Examples :—

Find interest on £945 10*s.* for 2 years 9 months at 4 per cent.

By the usual rule we find the interest for a year.

	£	s.	d.		
	37	16	$4\frac{3}{4}$ nearly	interest for	= 1 yr.
			2		
	75	12	$9\frac{1}{2}$	,,	= 2 yrs.
6 mon. = $\frac{1}{2}$ yr.	18	18	$2\frac{3}{8}$	,,	= 6 mon.
3 mon. = $\frac{1}{2}$ 6 mon.	9	9	$1\frac{5}{16}$	,,	= 3 mon.
	104	0	$1\frac{1}{16}$	,,	= 2 yrs. 9 mon.

If we want to find the interest for any number of days, if they do not form a convenient fraction of a year, we must proceed by a Double Rule of Three statement.

For example—Find interest on £1146 for 113 days at 2 per cent.

This question is really the following—If £100 yield £2 interest in 365 days, how much will £1146 yield in 113 days?

The statement will be

100 : 1146 }
365 : 113 } : : 2 : interest required.

Ans. £7 1*s.* 11*d.*

Example.—At what rate will a given sum double itself by simple interest in 20 years?

It is evident that all sums will double themselves in the same time; therefore we may consider this question to be—At what rate will £100 double itself by simple interest in 20 years?

The interest on £100 in 20 years is therefore £100

$\therefore$ the interest on £100 in 1 year is $\dfrac{£100}{20} = 5$;

i.e. the rate per cent. is 5. Ans. 5 per cent.

We may also consider the days as a fraction of a year, and calculate that fraction of a year's interest.

The general rule for finding the interest for any number of years would in this case be—Multiply the principal by the rate per cent. and the number of days, and divide by 365 × 100 —*i.e.* by 36500; or more conveniently, multiply by double the rate per cent., and divide by 73000.

Thus, the interest on £1146 for 113 days at 2 per cent. $= \frac{1146 \times 4 \times 113}{73000} =$ £7 1*s.* 11*d.*

There is a rule called "the third tenth and tenth rule," which gives a short method of performing the division by 73000. It is not absolutely accurate, but for all practical purposes it is accurate enough; and as it may save labour where calculations of interest for days have frequently to be made, we shall explain it here, though we do not think the ordinary student will make much use of it.

We shall not, of course, alter the result of our division if we multiply both divisor and dividend by the same number. Now, if we multiply both divisor and dividend by the number $(1+\frac{1}{3}+\frac{1}{30}+\frac{1}{300})$, the divisor 73000 becomes 100010 (omitting decimals). This is easily found thus :—

	73000
$\frac{1}{3}$	= 24333$\frac{1}{3}$
$\frac{1}{10}$ of $\frac{1}{3}$	= 2433$\frac{1}{3}$
$\frac{1}{10}$ of $\frac{1}{30}$	= 243$\frac{1}{3}$
	100010

The rule tells us to take as our new divisor 100000 instead of this 100010. If we do so, we are taking a divisor which ought to be increased by the $\frac{1}{10\,000}$ part of itself to be accurate, and so our quotient will be nearly the $\frac{1}{10\,000}$ part of itself too large. But taking this 100000 for our divisor, the division is performed by simply shifting the decimal point 5 places to the left. Hence the rule for dividing by 73000 will be—Take $\frac{1}{3}$ of the dividend, then $\frac{1}{10}$ of the result, and $\frac{1}{10}$ of this result, and add the three results to the dividend. Finally, point off five places of decimals. The result is the required interest (approximately). It is a little too large, on account of the divisor we used having been a little less than the true divisor; but we can make it almost exact by subtracting a farthing for every £10 of interest.

Example.—In how many years will a given sum treble itself at 5 per cent.?

The interest produced by £100 is £200—*i.e.* £100 produces £5 in 1 year: how long will it take to produce £200?

Clearly 200 ÷ 5—*i.e.* 40.

Ans. 40 years.

Exercises.

I. Find the simple interest

1.	On £198 6*s.* 8*d.*	for 2 years	at 3½	p. c.
2.	„ £556 13*s.* 4*d.*	„ 12 „	„ 2½	„
3.	„ £1873 2*s.* 6*d.*	„ 4 „	„ 2	„
4.	„ £198 6*s.* 8*d.*	„ 6 months	„ 7	„
5.	„ £1816 15*s.* 10*d.*	„ 5 years	„ 3¼	„
6.	„ £20000	„ 4 „	„ 3$\frac{5}{7}$	„
7.	„ £572 8*s.* 6*d.*	„ 10 „	„ 3½	„
8.	„ £20000	„ 1 „	„ 3$\frac{7}{8}$	„
9.	„ £1500	„ 2 yr. 9 m.	„ 1	„
10.	„ £16 5*s.* 10*d.*	„ 2 years	„ 4¼	„

II. Find the amount in each of the last exercises.

III. At what rate per cent. will

1.	£340 12*s.* 6d. amt. to	£381 10*s.*	in 3 years
2.	£136 17*s* 6*d.* „	£492 15*s.*	„ 6¼ „
3.	£100 „	£114 12*s.* 6*d.*	„ 4½ „
4.	£35 15*s.* „	£39 15*s.* 5¼*d.*	„ 4½ „
5.	£239 16*s.* 6*d.* „	£262 9*s.* 6*d.*	„ 34 mon.
6.	£525 „	£628 9*s.* 4½*d.*	„ 43 „

IV. Find what principal will produce

1.	£27 11*s.* 7½*d.*	interest in	9 months at	7½ p. c.
2.	£47 17*s.* 8*d.*	„	2½ years	„ 4$\frac{7}{8}$ „
3.	£36 12*s.* 6*d.*	„	1¼ „	„ 6¼ „
4.	£35 10*s.* 8½*d.*	„	2 „	„ 3 „
5.	£11 7*s.* 6¾*d.*	„	2 „	„ 2½ „
6.	£14 4*s.* 3¾*d.*	„	3 „	„ 3½ „

V. 1. A certain sum of money is placed at interest at the rate of 4¼ per cent., and in 16 months the amount is £39 12*s.* 6*d.*: what was the principal sum?

2. A person borrows £100, and at the end of each year pays £25 to reduce the principal and to pay interest at 4 per cent. on the sum which has been standing against him for that year. How much will remain of his debt at the end of 3 years?

3. The interest on £250 for 73 days amounts to £18 15*s.* Find the rate of interest per cent. per annum.

4. What sum of money bearing interest at the rate of 5 per cent. per annum will produce in 10 years as much as £350 produces in 15 years if lent at the rate of 2 per cent. per annum?

5. In what time will £125 bearing 4 per cent. simple interest amount to £250? and in what time will it be found to have quadrupled itself?

Answers to the preceding Exercises in Simple Interest.

I. 1. £13 17*s.* 8*d.*
2. £167.
3. £149 17*s.*
4. £6 18*s.* 10*d.*
5. £295 4*s.* 7*d.*
6. £2971 8*s.* 7*d.*
7. £200 7*s.* 1*d.*
8. £775.
9. £30.
10. £1 7*s.* 8½*d.*

II. 1. £212 4*s.* 4*d.*
2. £723 13*s.* 4*d.*
3. £2022 19*s.* 6*d.*
4. £205 5*s.* 6*d.*
5. £2112 0*s.* 5*d.*
6. £22971 8*s.* 7*d.*
7. £772 15*s.* 7*d.*
8. £20775.
9. £1530.
10. £17 13*s.* 6½*d.*

III. 1. At 4 per cent.
2. „ 3$\frac{1}{5}$ „
3. „ 3¼ „
4. „ 2½ „
5. „ 3$\frac{1}{3}$ „
6. „ 5½ „

IV. 1. £490 6*s.* 8*d.*
2. £392 17*s.* 9¼*d.* (nearly).
3. £468 16*s.*
4. £592 5*s.* 2*d.*
5. £227 11*s.* 2*d.*
6. £135 7*s.* 6*d.*

V. 1. £37 10*s.*
2. £34 8*s.* 11*d.* (nearly).
3. 37½ per cent.
4. £110.
5. 25 years; 75 years.

XXXIV.

GREECE (*continued*).

WHEN the system of Lykurgus had borne its expected fruit, and transformed the whole Spartan people into a standing army, they naturally began to look around for some one to fight,—just as Cetewayo is said to have looked out for some suitable neighbours in whose blood his warriors could "wash their spears." The Spartans had established themselves in the extreme south-east of the Peloponnesus, and on their west border was another Doric settlement called Messenia. These two states soon came into deadly collision. Two desperate wars, lasting for almost a hundred years (B.C. 750 to B.C. 650), took place before the Messenians were completely crushed. The whole of Peloponnesus was involved in the struggle—Argos and Arcadia on the Messenian side; Corinth and Elis on the Spartan. The Spartans were getting tired of the struggle, and were on the point of abandoning it, when the oracle desired them send to Athens for a leader. The Athenians not wishing to help them, and yet not daring to disobey the oracle, sent them a lame schoolmaster, Tyrtæus by name. But Tyrtæus was a poet and a man of spirit, and his martial songs and stirring exhortations so revived their failing courage that they carried all before them, and quickly conquered the brave Messenians and reduced them to slavery. For three hundred years the Messenians as a nation were blotted out, and only shook off their oppressors when the latter were overthrown by the Thebans in B.C. 369.

Spartan wars.

Messenia.

Tyrtæus.

The Spartans next turned their arms against their neighbours on the north. These were the Tegeans, and they proved a match for the Spartan bullies. The Tegeans, after inflicting many severe defeats upon their invaders—often turning the tables on them and making them labour in the very chains they had brought for the Tegeans—at last concluded a treaty of everlasting alliance with their baffled assailants (B.C. 560). The treaty was honourably carried out on both sides.

The Tegeans.

Meantime, changes in the form of government had been going on in most of the neighbouring states. The power of the kings had gradually declined, being supplanted by that of the nobles. These nobles were all ancient families, supposed to be descended from still more ancient heroes or half-divine persons. They were thus invested with a half-sacred character, which induced the common people to acquiesce more readily in their rule. They alone knew the laws, and handed them down by word of mouth; and they alone could conduct public worship. This form of government was called an Oligarchy (*oligoi* = few, *archē* = government).

Oligarchies.

But in most of the states, after a hundred years or so, some one man, more ambitious or more able, or more bent on reform than the others, generally managed to get the whole power into his own hands. This was usually accomplished by the aid of the common people, to whom he would make liberal promises of reforms in their favour.

Tyrants.

These men who overthrew the oligarchies and made themselves despotic rulers were called "Tyrants." It must not be supposed that they were so called because they were "tyrannical" in our sense of that word; "tyrant" implied nothing more than one who had set himself above the laws, and governed in spite of them. The mildest and most just ruler was a "tyrant" equally with the most cruel and oppressive, if he had raised himself to despotic power by trampling on the constitution. On the other hand, an Eastern despot, however tyrannical, was not called a "tyrant," because his power was given him by the laws of the country. But in the Greek states the elevation of one single member of the oligarchy to supreme and absolute power could only be effected by a revolution. The common people were generally very ready to assist a would-be Tyrant. They had nothing to lose if unsuccessful, while if the Tyrant succeeded by their aid he would be compelled to look to them for support against the envy and revenge of the nobles whose power he had superseded, and he would thus be obliged to give them privileges which before belonged exclusively to the nobles. In most states the commons were admitted by the Tyrants to participate in the public worship, and to take a subordinate part in affairs of state. The great and impassable gap between the nobles and the commons was reduced by depressing the nobles and raising the people. Thus the Tyrants were really the first to improve the condition of the mass of the people and fit them for the liberty and equality which they afterwards won for themselves by overthrowing the Tyrants. The first man who made himself a Tyrant in any state was almost always a useful man. His influence rested on his popularity with the people, which had to be well earned by carrying out with a strong hand much-needed reforms; but his power generally descended to his children or others who had done nothing to entitle them to be rulers, and were probably less able than their predecessor. Their position was much weaker than that of their founder, and they were generally driven to oppression and disregard of just rights in the effort to sustain themselves. Thus the word "tyrannical" came to have a meaning which at first was not at all implied by it.

Improvement in condition of the people under the Tyrants.

Sparta managed to preserve its kingly form of government; but Corinth, Sikyon, and Megara went through the same round of changes—kings, oligarchies, tyrants, democracies; passing through oppression to liberty and a broader national life.

The oppression of the people under the oligarchies, and of the nobles under the Tyrants, had at least one good consequence. It induced numbers of Greeks to go forth from their native states and found new ones; just as religious and political oppression in England under the Stuarts first drove Englishmen to settle in America and found a great empire there. They settled along the coasts of the Mediterranean and Black Seas, and especially in Italy and Sicily. They even wandered as far west as France, and there founded the town of Massilia, which is now Marseilles. These colonies became very rich by trade, and afterwards contributed much to Greek literature and art.

Colonies.

Besides Sparta, the only other Peloponnesian states whose history has much interest were Corinth, Sikyon, and Megara; and of these Sikyon and Megara were comparatively unimportant, so that we shall not stop to consider them. Corinth was the chief maritime state. Its position on the isthmus gave it great advantages for trading and shipping, and in consequence it was one of the richest and most highly developed of the states. It sent out many colonies; and one of its rulers, the Tyrant Periander (B.C. 625-585), was one of "the seven wise men of Greece," and a magnificent patron of art and literature.

Other Peloponnesian states.

His reign opened well, but as he grew older he became more and more tyrannical in the modern sense of the word. He lived apart from his people, and like a being of a superior order. His luxurious and extravagant manner of living were, however, atoned for by his liberal patronage of art and literature, and by his encouragement of colonization. Corinth grew immensely wealthy under his rule. But the fear that some other noble might supplant him drove him to crush out all liberty, and made him cruel and suspicious. He killed his wife in a sudden fit of rage, and when his son Sykophron refused in consequence to salute him, he drove the young man from his dominions. He died lonely and remorseful, after a reign of forty years.

XXXVII.

SYNTAX.

§ 229. The Province of Syntax.
§ 230. *Combination of Verb and Subject.* (*a*) Nominative and verb, (*b*) nominatives and *to be*, (*c*) verb and several subjects, (*d*) contraction of sentence with conjunction, (*e*) nouns joined by *or*, (*f*) by *and*, (*g*) collectives.
§ 231. *Combination of Attribute and Noun.* (*a*) Apposition, (*b*) attribute as predicate.
§ 232. *Combination of Verb and Object.* (*a*) Verbs with two objects, (*b*) apparent object of intransitive verb, (*c*) indirect object after impersonal verb.
§ 233. *Combination of Adverb* with verb, adjective, or adverb. (*a*) Position of the adverb.
§ 234. Minor rules. *Nouns.* (*a*) Nominative absolute, (*b*) nominative of address, (*c*) possessive.

§ 229. Apart from the properties of words, we take those rules which teach us how to form sentences, and the right use of the words and their inflexions. This we call *Syntax*. The arrangement or construction of sentences is made unconsciously in speech according to certain laws, which we often only recognize when they are broken. If a man says "I speaks true," we feel there is something wrong—what is it? each word is a good word: it is because forms are used which do not rightly go together; it is a wrong combination. "I" should be used with *speak*, not *speaks*; and again, *truly* is the form required by the verb; these words do not *agree* together. We have seen before (§ 81) that every sentence contains two notions—a Subject, and that which is said of it, the Predicate. Following the importance of the chief parts of speech, Syntax shows that in the four principal combinations of them used in making sentences, certain rules of agreement in forms must be observed. Here comes in the purpose of inflexion as a sign in syntax: "the more we lose inflexions the more we lose the signs of agreement, and it becomes an abstraction."

§ 230. (1) *Combination of* **Verb** and **Subject**.

ANCIENT GREEK COINS.
a and *d* Athenian. *b* Byzantine. *c* Messenian. *e* Theban. *f* Spartan.

—*The finite verb must agree in number and person with its subject.*

A finite verb is that part which is limited by time (tense) and person; the infinitive mood and participles are therefore excluded.

(*a*) The subject may be either a noun or pronoun; it is in the nominative case (*see* § 152): "I fall, rain falls, he falls." It would be wrong to say *you falls*, because *you* is second person and *falls* is for the third person. (*You*, though now signifying the singular in place of *thou*, retains the plural verb from force of habit: we do not say *you fallest*, though we address only one person.)

(*b*) Unlike most other verbs, *to be* takes a nominative case after it, as well as before: I am a man, This is he. A few others are sometimes followed by the nominative—as, She seems a fool, He is named Tom, William became king. (These are passive verbs.) These nominatives, referring to the same person, resemble nouns in apposition (*see* § 231, *a*).

(*c*) Two or more nouns in the singular, joined by the conjunction *and*, take a plural verb: The boy and girl *were* ill; but the same joined by the conjunction *or* take a singular verb: The boy *or* girl *was* ill. *Nor* is also followed by a singular verb.

(*d*) The reason is this: every term joined by *and* belongs to an ideal sentence—The boy was ill, *and* the girl was ill; the use of *and* joins the one verb to each subject in the same sense, and thus puts the verb of the contracted sentence in the plural. The ideal sentences joined by *or* and *nor* are by the effect of those words *disjoined* in sense; the contracted sentence therefore has a singular verb to agree with each subject: The boy was ill *or* the girl was ill, Neither the boy was ill *nor* the girl was ill. (Remember that *or* comes from other or either, *nor* from neither. § 216.)

(*e*) When two or more nouns joined by *or*, *nor*, are of differing number or person, the verb agrees with the noun immediately preceding it: Neither the man nor children *are* here, Neither children nor man *is* here.

(*f*) This rule regarding nouns joined by *and* was not strictly in force in middle English, when such a usage as "Flesh and blood *hath* not revealed it" obtained; indeed, we still can say "the bread and butter *is* cut," "to read and write *was* once an honorary distinction" (*Hazlitt*, quoted by Canon Daniel). The idea was singular, and that gave direction to the verb; even where there were several nominatives the idea of the one nearest to the verb seemed to remain upon the mind, and thus brought out a singular verb instead of a plural: "Thine *is* the kingdom, and the power, and the glory" (*Lord's Prayer*, Matt. vi. 13); "Her heart, her mind, her love *is* his alone."

(*g*) Collective nouns in the singular sometimes take a plural verb. as shown before (§ 144). If the verb refers to the action of the subject as a unit, it should be singular: The infantry *is* marched from London to York; if the action is said of the parts of the subject the verb is plural: The infantry *march* fast. Pronouns representing these nouns must of course agree in number. An excellent instance of the two modes of use is given by Professor Morley: "Behold the people *is* one, and *they have* all one language" (Genesis xi. 6); in the first case the idea is of the people in its unity, in the second that of each person speaking.

§ 231. (2) *Combination of* **Adjective**—*or word doing duty for adjective*—and **Noun.**—A word that qualifies or adds to the sense of a noun is in Syntax said to be an *Attribute*. Thus an adjective is an attribute to a noun in "a good man." An adjective-attribute is placed close to its noun, either before or after it:

> "The *stately* elephant from the *close* shade
> With step *majestic* strides."
>
> SOMERVILLE, *The Chase*.

(*a*) When two nouns, or a noun and pronoun, refer to the same person or thing, they are said to be in *Apposition:* they must be in the *same case* and generally agree in *number*. The second noun in apposition is an attribute of the first. Thus, "*James* the *barber* shaved him."

> "The *lark*, *herald* of the morn."
> "Thou *sun*, of this great world both *eye* and *soul*." MILTON.

Barber is in apposition to James, and agrees with James in singular number and nominative case. If the nouns in apposition are in the possessive case, only one of them is inflected: "I have my brother John's coat."

A noun in the possessive or genitive case is an attribute to the noun governing it: The *sun's* light, a *ship's* mast, a knife *of iron*, a heart *of stone*.

The preposition *of* is frequently the sign of an attribute, not only in the Norman genitive, but before some nouns (chiefly place-names) in apposition—as "the town of Birmingham."

(*b*) An adjective when placed after the verb *to be*, and after some other verbs which bear a sense of personal existence, is treated as part of the predicate: Life is long, An apple was sweet, She turns red, The air feels cold, The case becomes serious, This appears good, That sounds hard; "Grief was heavy at his heart."

In each of these the adjective is, however, really an attribute of the subject; this is the distinction between such sentences and others like "the fire burns hot," "the apple tastes sweet," in which *hot* and *sweet* are adverbs, modifying the verb and not the noun. The former answer the question *What?*—"What is life?" the latter answer the question *How?*—"How burns the fire?"

§ 232. (3) *Combination of* **Verb** *with its* **Object.**—A transitive verb requires a *direct object* (§ 82). This is put in the *accusative* (or objective) case: John beat the *ass* and killed *him* (not *he*).

(*a*) Some transitive verbs—as *give, teach, call, promise, tell, lend, ask, forgive, make*, etc. —take two objects after them, an indirect and a direct; the *indirect* is in the *dative* case (§ 153), and precedes the direct object: "She gave *me* a kiss"; John lent *her* some money, The master teaches *his pupils* Latin. The passive of such verbs will take one object, a direct one—as, She was lent *some money*, The pupils were taught *Latin*.

(*b*) As was shown in § 83, intransitive verbs sometimes take a direct object of the same idea as the verb: He *lived* a righteous *life;* they also are sometimes followed by an object showing space or time: I ran *six miles*, He

coughed *all day*. (These last are of the nature of adverbs.)

(*c*) Impersonal verbs—such as *befall, behoves, like, please, seems*—are followed by the indirect object: A misfortune has befallen *him*, It behoves *you* to take care, It seems to me (me seems), "This that liketh *us* so well" (*Ferrex and Porrex*). The old verb *worth* (German *werden*), meaning *become* or *be* to, took the indirect object—Woe worth the day!

§ 233. (4) *Combination of* **Adverb** *with* **Verb, Adjective,** *or* **Adverb.**—It has been shown before (§ 92) that adverbs affect these words in the four ways of *time, place, manner, cause* and *effect*. It must also be again noted here that an adverb in syntax may be either a single word or a group of words; the group being either a phrase (*see* after, § 242)—I will be careful *for the future*, or a sentence (§ 243)—He will do *as you advise*.

In the use of adverbs of manner there is sometimes a little confusion with adjectives of the same form—as in "the apple tastes sweet" (*see* § 206): it must be remembered that these come from the Old English, and are nearly all monosyllabic. All adverbs of manner formed from Latin or French (or other) tongues take the suffix *ly—exceedingly, correctly, particularly, richly, privily*, etc.; though poets occasionally take licence in this respect—as Pope: "They fall *successive*, and *successive* rise."

"His seat, where solitary sports are seen,
Indignant spurns the cottage on the green."
GOLDSMITH, *Deserted Village*.

(*a*) The *position* of the adverb must be attended to; there is some laxity about this because in many cases it may be movable. The adverbs modifying the *verb* may be movable, especially those regarding *time* and *place:* He went *yesterday*, *Yesterday* he went, He *yesterday* went, can all be used; the general rule is, *place the adverb after the verb, and between the auxiliary and the participle:* She goes *this year* to Germany, He is *slowly* dying, The table is *partly* polished.

"Man wants but little *here below*,
Nor wants that little *long*."
GOLDSMITH, *The Hermit*.

When the adverb is intended to modify an adjective, or another adverb, it must be placed close to that word: "In sorrow *doubly* dear," "Kingdoms to *sickly* greatness grown," "States though *very* poor may still be *very* blest."

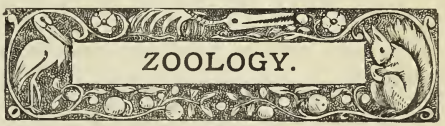
The adverb must be placed close to whichever word it modifies if there is a special meaning intended. "I am *only coming* to see you" may mean that I am *coming* because I am doing nothing else; "*Only I* am coming to see you" means that but one person is coming; "I am coming to see *only you*" (or "*you only*") emphasizes the object. In truth, the word becomes more adjective than adverb in the two last arrangements.

§ 234. Attention must be given to a few other rules connected with the different parts of speech; they should be studied together with the foregoing. **Nouns.**—(*a*) A subject (noun or pronoun) combined with a participle, but not connected with a finite verb or governed by any other words, is called the *Nominative Absolute: All being well*, I will come; The *circumstances considered*, he was fortunate; *This done*, I proceed to business. (These phrases stand in the place of adverbs, and in Analysis are called participial extensions of the predicate.) *Note* that there are two subjects in the sentence, and that the participle bears a verbal power; if there is only *one* subject in the sentence it belongs to the finite verb, and is not absolute, while the participle becomes an attribute, as "*All*, being well, *will* come." When there is an adverb the participle may be omitted, being understood: "All . . . well, I will come."

The subject absolute is needed in other languages: Latin puts it in the ablative case, Greek in the genitive case. In Old English it was put in the dative; but as the case-endings were lost the dative sense was lost too, and only the nominative form remains.

(*b*) The *noun* (or pronoun) *addressed*, either with the imperative mood, or following the interjection O! is said to be in the nominative case: Tom, come here; O! mother, see; Go away, you naughty boy.

(*c*) As to the possessive case: the first of two nouns (or a pronoun) possessing that relation is put in the genitive: Philip's dog. What seems to be a double possessive sometimes occurs—as, A friend of my mother's; it is, however, but a contracted phrase—A = one, one friend of my mother's friends, *of* being the preposition *from* (*see* § 213).



XII.

THE NEW WORLD MONKEYS.

TURNING to the monkeys of Central and South America, whose principal characters have already been mentioned (p. 144), we must first deal with one group, of whom Mrs. Cluppins might truly say, "The voices was very loud, sir, and forced themselves upon my ear." These greatest of American monkeys, the Howlers, nearly three feet long, not reckoning the tail, congregate in large numbers in the Amazon forests, and hold a night and morning concert for several hours, the males having by far the loudest voices, and their yells being audible for quite two miles. The throats of these creatures, of which ten species are known, are much swollen, and a remarkable set of resounding chambers is formed by enlargements of the usual small bags or sacs of the larynx or voice-box, and also by a strange structure of the bone beneath the lower jaw, to which many of the tongue-muscles are fixed. This bone, instead of being slender and solid, is scooped out so as to form a large drum, into which air gets by a small opening. These monkeys are by no means playful, but rather boorish and melancholy in disposition. Their long and

The Howling monkeys.

most sensitive tail grasps and feels with as much accuracy as a hand; they can suspend the entire body by the tail, and employ it for most rapid motion from bough to bough in the forests. They live on vegetable food, and their flesh is decidedly attractive, like that of many American monkeys, to the Indians, who derive from them important supplies of animal food.

The Woolly monkey.

Humboldt's Woolly monkey of the Orinoco is not a howler, but its tail is longer than its body, and it has well developed thumbs. It is notable for having fourteen pairs of ribs, and for its fur bearing considerable likeness to that of the hare. Other species of woolly monkeys inhabit the regions of the upper Amazon and the slopes of the Andes in Bolivia and Venezuela.

Spider monkeys.

The Spider monkeys are so termed because in them the limbs are so slender in proportion to their length. The tail is also very long, sometimes twice the length of the body, flexible to the last degree, capable of perceiving the movements of the air so accurately that it appears as conscious of the nearness of an object to which it can cling as if it had an eye at the tip. In very many respects the tail acts as an additional and most valuable limb; by it the creatures swing about, catch the branches they leap towards, and suspend themselves. They are exceedingly playful and social, and may be seen sometimes in groups clustered together, all supported by the tail of one stronger fellow. For anatomists one of their noteworthy features is the complete absence of the hand-thumb, or its reduction to a slight projection. The thumb-bones are incomplete, but the thumb-muscles are present, though small. The brain is somewhat narrow but long, the hind lobes extending backwards over the small brain or cerebellum. The toe-thumbs are good. Their diet is chiefly derived from the vegetable kingdom. There are many species, distributed over the Central and South American forests down to thirty degrees south of the equator. One very hairy long-limbed creature, with face almost bare, is named "hooded," from its brow being overhung with the long hair of the scalp.

Capuchins.

The active Capuchins, which turn the ends of their tails downwards instead of carrying them habitually upturned, include nearly a score of species, among the best known of American forms. Some are the most perfect of leapers, untiring in their activity. A typical Capuchin is very docile and teachable in captivity if caught young. He becomes attached to those he lives with, and even to other domestic animals. He is very prone to thieving, and learns by experience. The first time an egg is given him he breaks it so as to lose much of the contents; but on a repetition of the experiment, he succeeds in keeping safely the whole of his egg. Their frolicsome nature is thus described: "They are fond of teasing, and pull the tails of dogs and cats, snatch the feathers out of hens and ducks, and even tease horses which are tied up close to them."

The little, noisy, affectionate Squirrel monkeys have long tails, not used as "fifth limbs,' but rather serving the purpose of a cat's tail. Some of them are very fond of insects and birds. Some are chiefly active at night. The true night-loving or Owl monkeys are not well known, for they are not easy to tame. At night they have a cry like the hoarse barking of a dog. They live largely upon insects and spiders. By day they conceal themselves and sleep in the hollows of trees. In some points they remind one of a cat—in their action with the paw, and in their hissing. In some of these there are fourteen, in others fifteen pairs of ribs.

Squirrel and Owl monkeys.

The Sakis.

Among another important genus of American monkeys, the Sakis, some have non-grasping tails of considerable length, others have them much reduced—even as short as three inches. Every species seems to possess a peculiar arrangement of its hair, the effect produced being often so striking as to have given origin to the specific names "monk," "bald," hirsute, Satan, etc. They are rather shy, though tameable when young, and not so frolicsome or mischievous as some. One large species is called the Hand-drinker; for he has a somewhat handsome beard, and is most careful to keep it dry, and consequently takes up water in the hollow of his hand and carries it slowly to his mouth. Mr. Bates tells an interesting story of one species, an individual of which was kept as a pet by a friend, and became much attached to him. One day, being left at home contrary to custom, he found out for himself a short cut over gardens, trees, and thickets, to Mr. Bates's, where his master paid a daily visit. Another form should have some description of its hairy covering given; for it has whitish hair all over it, behind the neck, while the head has a few short grey hairs, and the face is scarlet. Add to this, tufts of sandy whiskers and reddish-yellow eyes, and imagine a group sitting gravely together, and surely a striking picture will be called up.

Marmosets.

The Marmosets have hands and feet approaching the cat type, having the thumb but slightly separable, and all the digits being provided with a claw-like nail. The most common species has a bush of whitish hair projecting on either side of the head, behind the eyes, and reaching nearly to the top of the crown, giving it a quaint appearance. They move and jump very rapidly among trees, in small groups. Some striking stories of their affection for one another are told, extending even to their dying of grief for a deceased companion. The Midas monkeys, which are closely allied to these, are small and squirrel-like, one species having a body only seven inches long. They can even make a warm home for themselves in the long hair of the Indian women of the upper Amazon. They are very active, and like the Marmosets, feed largely on animal food, especially insects and small birds, although they also indulge in fruit and eggs.

Midas monkeys.

LEMURS.

The Lemurs, already referred to (p. 109), derive their name, which means "ghosts" or

"spectres," from the nocturnal habits of many of them. While they share with the monkeys the possession of hand- and toe- thumbs, they are regularly four-footed, with hind-limbs longer than fore-limbs. They have a furred coat and tail, and never possess cheek-pouches or hard bare patches of skin to sit upon. They are most markedly distinguished by their great eyes, long ears, and broad fox-like face, much unlike the apes.

Still more separated are the Lemurs in their characteristic home, the forests of Madagascar, where no monkeys dwell. Some forms extend into east and west Africa; and the only other localities in the world where any of them are native are parts of India and China, Ceylon, and the large Malay islands. The various species appear to be the surviving descendants of creatures that inhabited a former continent which connected all these countries and islands by continuous land. What parts of the Indian Ocean were then occupied by dry land we must leave to the geologist to discover. The Lemurs give abundant scope for some of those speculations about the past history of animals and of the globe alluded to on p. 44. They cannot swim across the seas to find new homes; and we have to account for the presence of closely-related forms at such wide distances in space. Past changes in physical geography, with the slow modification of species by natural selection, furnish rational principles upon which we may come to understand much that now strikes the traveller and naturalist as inexplicable.

RING-TAILED LEMUR.

The genus Lemur includes a considerable number of species which live in Madagascar, or on small islands near its shores. One of the better known species, the Ring-tailed lemur, also called the Cat-like lemur, has a tail considerably longer than its body, and its fur is composed of alternate bands of black and white. A great part of the body is grey-coloured, with white below; the head also is white for the most part, but the snout is black. They do not resemble cats in having tactile whiskers. Their back is high because the hind-limbs are higher than the fore-limbs. As regards the teeth, there are thirty-six in all, well adapted to vegetable food, as is also the intestine; but these lemurs do not abstain from insects, or occasionally small birds. They have thirteen pairs of ribs. There are some very interesting features in connection with the fingers and toes. Thus, the fourth is the longest of both, instead of the middle one as in ourselves. The second or index finger is less than in monkeys and ourselves. This helps to render the thumb a more perfect grasper. Their exquisite sense of touch with both palms and soles is given by little cushions of skin, fat, and nerves, at the ends of the digits. One and all, they jump with great activity and accuracy; but they do not show such intelligence as the monkeys, either in playing with or teasing each other, or in adapting themselves to mankind. One of the tamest species is the Ruffed lemur; another is the Black lemur, living socially on the upper boughs of lofty forest trees, moving about in the evening, and being heard by their various cries, rather than seen. To know all the forms of lemurs it is necessary to trace the changes that occur with season and with age, and the distinctions of colour, often striking, between male and female.

Structure.

Habits.

Indris are lemurs with six fewer teeth than the rest, the lower canines being absent in the adult, and the lower incisors projecting remarkably forward. Some of them can progress when on the ground, by hopping on the hind-legs; at home in the trees they jump with wonderful certainty. The Weasel lemurs have no front teeth at all in the upper jaw in the adult set.

Indris.

An animal named the Flying lemur, found in the Malayan islands, deserves mention here, although it is now decided that its proper place is among the Hedgehogs. It is distinguished by a broad membrane extending all round its body to the extremities of the toes, and tail; and by this it can pass obliquely from one tree to another, even at a distance of seventy yards. The lower incisor teeth are most remarkable, being slit downwards by a number of fissures, in appearance like a comb.

XXXI.

The Verb—Theory.

The sequence of words by which we express our thoughts constitutes speech. Speech is made up of sections called phrases, each of which presents a complete thought, or a combination of thoughts closely connected. When we give utterance to a simple thought—that is, when we express by sound or writing a judgment formed in our understanding by the comparison of two ideas only—we make up a proposition. For a simple yet perfect proposition but few words are required: one word for the *subject*, of which we affirm or deny something; one word for the *predicate*, which is what we affirm or deny of the subject; and *the* word which connects the predicate with the subject, and which is the *copula*, or *verb*. Speaking strictly, the verb does more than connect: it affirms or denies the predicate of the subject. It forms thus an indispensable part of discourse, whether it presents itself under its simple form of some portion of the verb *être*, or under its complex form, combining copula and predicate in what French grammarians call the attributive verb (*see* vol. ii., *p.* 59), as when we say *il aime*, which stands for *est* (copula) and *aimant* (predicate). [This construction *est aimant*, which sounds so familiar to English ears, is employed for explanatory purposes, and never appears in French speech.]

We shall consider in succession the three parts which constitute a proposition: 1. Subject; 2. Verb; 3. Predicate.

1. The Subject.—This term may be viewed in two ways: logically, as we have done above, or grammatically. In the latter case it means the being or the thing which does the action or which is in the state described by the attributive verb.

One discovers the subject by asking the question, *who does?* or *what does?* in French *qui est-ce qui . . . . ?* for persons, and *qu'est-ce qui . . . ?* for things. Ex. *Un tyran opprime les faibles*, a tyrant oppresses the weak. Who does oppress the weak?—A tyrant (*Qui est-ce qui opprime les faibles?—Un tyran*). The subject is *tyran*, as it does the action marked by *opprime.—L'arbre tombe sous la hache*, the tree falls under the axe. What does fall?—The tree (*Qu'est-ce qui tombe?—L'arbre.*) The subject is *arbre.*

The name of the person or thing apostrophied is said to appear in the *nominative of address —nominative* being another name for subject. This in French is called *sujet mis en apostrophe*, and in the classical languages the *vocative.* Ex. *Pour soulever un poids si lourd*, Sisyphe, *il faudrait ton courage* (Beaudelaire), in order to raise so heavy a load, thy courage would be required, O *Sisyphus.*—Bois *que j'aime, adieu, je succombe* (Millevoye), beloved *woods*, farewell, I succumb.

The subject may be:—

a. A noun:

La *mort* ne surprend pas le sage (La Fontaine), death *does not take the philosopher unawares.*

b. A pronoun:

Il est toujours prêt à partir (do.), he *is always ready to go.*

c. A verb in the infinitive:

Aimer est un besoin de l'âme (de Ségur), to love *is a necessity for the soul.*

d. Any part of speech used substantively:

Le *plus beau*, dans les belles actions, est de vouloir les cacher (Pascal), *the* finest (*feature*) *in beautiful actions is to wish to hide them.*

e. A whole proposition:

Il vous faut est fort bon: mon moulin est à moi tout aussi bien, au moins, que la Prusse est au roi (Andrieux), You must have *is all very fine; at the very least my mill is as much my own as Prussia is the king's.*

The subject very often follows the verb instead of preceding it; but whether it be placed in the one or the other position it is so in accordance with very distinct rules, which will be given hereafter. Ex. *Que pouvaient mes amis* (Chénier)? what could my friends (do)? *Mes amis* subject to *pouvaient.*

A single word may serve as subject to several verbs in the same phrase, being understood before the verbs that follow the first in the series. Ex. *C'est en vain qu'il tempête et feint d'être en fureur* (Corneille), in vain he storms and pretends to be in a rage. *Il* subject to *tempête*, and subject understood before *feint.*

Several subjects may have one verb in common. Ex. *La* Disette *au teint blême, et la triste* Famine, *les* Chagrins *dévorants et l'infâme* Ruine *troublent l'air d'alentour de leurs gémissements* (Boileau), livid-faced *Want* and dejected *Famine*, gnawing *Griefs* and *Bankruptcy*, disturb the ambient air with their groans. In a phrase there will be as many propositions as there are verbs in a personal mood, and every personal mood must have a subject expressed or understood. The infinitive, marking the action in a general manner, possesses no subject, and is called the *impersonal* mood, as it cannot mark the distinctions of persons and numbers. As for the imperative, we may in most cases consider the subject as being understood; and when it is expressed, it presents itself as the nominative of address. Exs. *Serrez vos rangs*, close up the ranks. Here the subject *soldats* (soldiers) may be understood.—*O* vous *donc qui, brûlant d'une ardeur périlleuse, courez du bel esprit* la carrière épineuse, n'allez pas sur des vers sans fruit vous consumer* (Boileau), O *you*, then, who burning with a dangerous ardour, are treading the thorny paths of letters, do not go and consume yourselves fruitlessly over verse-making.

We present now a few hints for the discovery of the subject.

a. The relative pronoun *qui*, coming after

* *Bel esprit* here is taken in a favourable acceptation.

its antecedent, is always subject to the verb which follows it :

La déesse en entrant, *qui voit* la nappe mise, admire un si bel ordre et reconnaît l'Eglise (Boileau), *on entering, the goddess* who sees *the table spread, admires so beautiful an appointment, and recognises the Church. Qui* subject to *voit*, which follows it.

b. The construction *celui qui*, he who, contains two subjects—*qui*, which is always subject to the first verb, and *celui*, to the second :

Celui qui met un frein à la fureur des flots, *sait* aussi des méchants arrêter les complots (Racine), *he who curbs the fury of the billows, knows also how to mar the plots of the wicked. Qui* subject to *met ; celui* subject to *sait.*

c. It often happens, especially in proverbs, that, for the sake of terseness, there occurs an ellipsis of *celui* in the just-mentioned combination. For purposes of parsing this must be restored :

Qui aime bien châtie bien, *who loves well chastises well. Qui* subject to *aime ; celui*, understood, subject to *châtie.*

d. Quiconque, as the corresponding English term *whoever*, stands for two nominatives :

Quiconque (*for* celui qui) flatte ses maîtres les trahit (Massillon), *whoever* (for *he who*) *flatters his masters betrays them. Celui* subject to *trahit ; qui* subject to *flatte.*

e. In those phrases where the indefinite form *il*, it, is the *apparent* subject of the verb, two views may be taken of the construction : either we may say that *il* is used pleonastically, expletively, or that the real subject forms an apposition to it :

il est midi, *it is noon*, stands for il, midi, est ;

il est un juge au ciel, *there is a judge in heaven*, stands for il, un juge, est au ciel ;

il y a des hommes, *there are men* = il, des hommes, sont ;

il vous faut des bottes, *you require boots* = il, des bottes, *vous manquent*, or *vous sont nécessaires.*

f. In such phrases as *il pleut, il grêle*, etc., it is difficult to suggest a *real* subject other than *il*, unless we choose to say *le ciel pleut*, etc. All purposes of parsing will be suited by calling here the indefinite *il* the subject to *pleut, grêle*, etc.

2. THE VERB.—The general principle that the verb agrees in number and person with its nominative has already been sufficiently apprehended by the learner. But important modifications are connected with this principle ; and although the whole matter really belongs to the syntax, it will be useful to mention the leading facts now.

a. The verb having several subjects joined by *et* is usually put in the plural :

Le mien et le tien ne s'accordent guère (Marmontel), *meum and tuum do not harmonize much.*

b. Although the subjects may not be joined by *et* the verb is plural, being made to agree with them all, if the various parts are not explanatory of each other, as they would be in the case of synonyms, and if, therefore, each part is essential to the complete sense of the phrase :

La flatterie, la perfidie, l'abandon de tous ses engagements sont le caractère de la plupart des courtisans (Montesquieu), *flattery, treachery, the breaking loose from all duties, constitute the disposition of most courtiers.*

But the interpretation of those two rules seems to admit of the utmost latitude ; it is sufficient that in the mind of the writer two ideas, which at the first blush seem diametrically opposed, may have some connection to justify him in considering them as one, and placing the verb in the singular number as a consequence. In verse the point is entirely left to the poet's discretion. Exs. *La* sagesse *et la* pitié *du souverain* peut *faire toute seule le bonheur des sujets* (Massillon), the wisdom and pity of the sovereign is able by itself to constitute the happiness of the subjects. *La sagesse* and *la pitié*, in the mind of Massillon, presented but one idea.

" . . . Quel nouveau trouble *excite* en mes esprits,
Le *sang* du père, ô ciel, et les *larmes* du fils
(Racine),

O heaven, what new confusion does *the blood of the father and the tears of the son* excite *in my mind!* To have written *excitent* would have given one syllable too many for the line ; and whether for this reason or some other, the poet availed himself of the legitimate *licence.*

There are cases where a plural verb after a double nominative connected by *et* would prove a positive mistake, as altering the sense of the phrase. Ex. *Un soldat et un Français, n'abandonne pas son drapeau* (Larousse), a soldier and (one who is at the same time) a Frenchman does not forsake his colours. *Soldat* and *Français*, here, can only mean one individual.

c. When the subjects belong to different persons the verb is put in the plural and agrees with the person having priority—the 1st coming before the 2nd and 3rd, and the 2nd before the 3rd. In such cases it is not unusual to sum up the different subjects into the plural pronoun of the person having precedence—as, for example, Thou, he, and I have = *toi, lui et moi, nous avons ;* Thou and Andrew have = *toi et André, vous avez :*

Athéniens, ne soyez pas surpris que Démosthène et moi ne soyons pas du même avis. *Athenians, be not surprised that Demosthenes and I should not be of the same opinion.*

Narbal et moi, nous admirâmes la bonté des dieux (Fénelon), *Narbal and I admired the kindness of the gods.*

d. The verb agrees with the latter of two subjects when *ou*, with a disjunctive meaning, is placed between them. Should *ou* have the conjunctive meaning, or the subjects be of different persons, the verb would appear in the plural. Exs. *C'est Cicéron ou Démosthène qui a dit cela*, it is Cicero or Demosthenes who *has* said that : an alternative is presented to the mind—either the one or the other said that, but not both.—*Ce sera son père ou sa mère qui obtiendra cela de lui*, it will be his father or his mother who will obtain that from him ; this is again an alternative, the use of the disjunctive *ou*, here, excluding the one or the other.—*L'abstinence ou l'excès me fit jamais d'heureux* (Voltaire), abstinence or excess never made happy men. But Massillon writes quite correctly, *Le bonheur ou la témérité ont pu faire des héros*, luck or rashness may have succeeded in making heroes, because to Massillon's mind these terms presented some affinity ; and indeed luck and rashness are not ideas that exclude each other, as, *e.g.*, rashness and timidity would.—*Lui ou moi ferons cela* (Littré), he or I will do that : different persons.—Le roi, l'âne, *ou moi, nous mourrons* (La Fontaine), the king, the ass, or I, will die : the introduction of *nous* here is precious for euphony.

e. When *ni*, with a disjunctivem eaning, precedes each subject, the agreement takes place with the latter. But the alternative requires to be very distinct, else the greatest latitude is exercised in this construction. Exs. *Ni l'un ni l'autre n'*EST *mon père*, neither the one nor the other is my father : both could

not be.—*Ni l'un ni l'autre ne* SONT *pères*, neither is a father: both could be fathers, and at the same time, hence *ni* appears in the conjunctive meaning, and the verb is plural. In the majority of cases the writer decides for himself; and Littré says that it is equally correct to say *Ni la douceur ni la force n'y* PEUT *rien* or *n'y* PEUVENT *rien;* La Fontaine writes in one part *Ni mon grenier ni mon armoire ne se* REMPLIT *à babiller*, and in another *Ni l'or ni la grandeur ne nous rendent heureux.* The same latitude is observable with *ni l'un ni l'autre* as with *l'un et l'autre: Ni l'un ni l'autre n'*ÉTAIT courtisan (La Harpe); *Ni l'un ni l'autre n'*ÉTAIENT *courtisans* (Littré); *l'un et L'autre vous* A *obligé* or *vous* ONT *obligé.*

f. When the subjects are synonymous, in which case, a few examples to the contrary found in good authors notwithstanding, they ought not to be joined by *et:*

La fierté, la hauteur, l'arrogance *caractérise* l'Espagnol, *pride, presumption, arrogance*, characterizes *the Spaniard;* Leur vie, leur sûreté, leur existence *est* dans vos ports (Thomas), *their life, safety, existence*, is *in your harbours.* In such phrases there is in reality no addition, but a substitution of one term or idea for those which precede.

g. When the subjects are arranged so as to form a climax:

Ce sacrifice, votre intérêt, votre honneur, Dieu vous le *commande* (Domergue), *your interest, your honour, God* demands *this sacrifice:* honour absorbs interest, and God absorbs both—one idea left. Un jour, une heure, un instant *pouvait* rendre le péril mortel (Mirabeau), *the delay of a day, of an hour, nay, of an instant*, could *render the danger fatal.*

[A few special cases are left over for next lesson.]

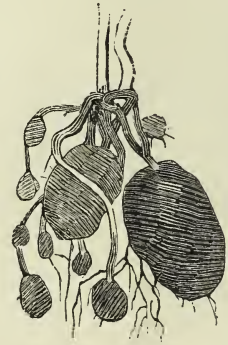


FIG. 197.—POTATO.

BOTANY.

XXXVIII.

VARIOUS ORDERS (*continued*).

IT is the destiny of several even of the rather extensive orders to be rich, not in floral comeliness, or in luxuriance simply of leaf, but to be weedy and often coarse and rude-looking. Among their species are nevertheless found plants which in good qualities counterbalance this deficiency of gay looks, and quite reconcile us to the general unpretentiousness. Such an order is the one we now proceed to deal with—an order familiar in the wayside docks and persicarias, and in the huge rhubarb of the kitchen-garden. This is the first order, moreover, we have come to in our survey, in which the flowers are normally *incomplete.* In the Polygonaceæ, that is to say, the perianth is single. As described in an early chapter, when petals are wanting in a flower it is customary to regard the floral envelope, however bright may be its hue, as simply and only a calyx. In the Polygonaceæ it sometimes happens that the pieces of the flower are in two distinct whorls, but the analogy of other parts shows that they are still to be considered "monochlamydeous." Extremely pretty little flowers are quite common in the order—none excelling in fairy-like elegance those of the common birds'-knot-grass, an inhabitant of every bit of waste land and of every cornfield in the country. When aggregated, the multitude not unfrequently gives them a certain showiness, but we must never look in the Polygonaceæ for anything that will remind us of lily or rose. Happily the entire order is innocuous—though oxalic acid is secreted by some of the species, and in several instances is a source of nutritious food. In tropical and sub-tropical countries a few ligneous species occur, stout shrubs and small trees. But the great mass of the order is herbaceous. The leaves are alternate, simple and undivided. The stipules, when present, are membranous, and form, as above described, a kind of sheath round the lower portion of the internode. The inflorescence is usually either spicate or paniculate. The stamens correspond in number with the five or six pieces of the perianth. The fruit is usually a little dry nut, often triangular, and often beautifully polished. After the ubiquitous weeds just referred to, the docks and persicarias, the commonest wild British examples are the sorrels; while as cultivated examples may be cited as invaluable, rhubarb, already named, and buckwheat. Of rhubarb, there are at least half a dozen different kinds, all of them natives, it would appear, of the region which lies to the right and left, or east and west, of the great rivers that form the boundary line between Europe and Asia. The Himalayas have their species as well. "Turkey rhubarb," the kind employed in medicine, is so called because the drug was originally received by way of Constantinople, though the plant itself grew in some unknown district far away,—just as we call a certain Indian plant the *French* bean. The rhubarb employed for tarts is a different species, though the roots are said to possess qualities faintly resembling those of the Turkey. A rhubarb plant in full bloom is a noble spectacle, the vast and erect panicle of myriads of cream-white little flowers rising out of a most curious sheath or pocket. Buckwheat is the seed, or fruit, more properly, of the *Fagopyrum esculentum.* The peculiarity of the seed is that, as in all the rest of the Polygonaceæ, it consists chiefly of free albumen. Cut one in half, and it seems to be made of the purest and whitest wheaten flour. Not only for human food, but for pheasants and other game-birds, buckwheat is held deservedly in high esteem. It was stated in the chapter upon fruits, that very often it is not simply the ovary which becomes the fruit of the plant,

The Polygonaceæ.

some other portion of the flower contributing. In the Polygonaceæ there are several striking examples of this, notably those furnished by the so-called "seaside grapes" of the West Indies, which are the produce of different species of Coccoloba. To comprehend their nature we need look only at the pretty little pearly fruits of the Muhlenbeckia, a plant of the curiosity-greenhouse, which are found to be in reality the perianth enlarged and distended with juice, the ovary *ipsissima* lying in the heart. Not many ornamental plants belong to the ranks of the Polygonaceæ. The crimson oriental persicaria, now rather a rarity, is a very desirable annual; and where a huge bush is wanted, just for the summer and autumn, in October to be overlaid with creamy bloom, the plant absolutely matchless is *Polygonum Sieboldii*.

Apetalous flowers constitute one of the leading features also of the very beautiful and interesting order which in England is represented by the common Mezereon. Every one who looks out for the earliest heralds of the spring is familiar with the delicate red flowers seated so closely upon the long bare twigs that they seem to grow in spikes, and exhaling an odour that is not many removes from spicy and aromatic. This engaging shrub, wild in the woods in some of the southern English counties, is unfortunately of evil repute in respect of secret qualities. The red berries are deleterious, and the juice of the bark is so acrid that if a piece be rubbed against the skin it will raise a blister. It is one of the genus Daphne, several other species of which are renowned for their fragrant flowers, and therefore cherished in conservatories. Under glass, too, we find many kinds of lovely shrubs from Australia and the Cape of Good Hope, named gnidia and pimelea. These produce their little flowers in terminal umbels, and never fail to inspire interest. Shrubs and a few small trees represent the principal forms characteristic of the order. The leaves are simple and undivided, alternate, or scattered, and often very narrow. The flowers are mostly either tetramerous or pentamerous. The constituent pieces of the single perianth are united for nearly their whole length, so as to form a tube, in which the stamens are seated, the lobes spreading horizontally. The stamens seldom exceed eight in number. The fruit is usually some kind of berry.

The Thymelaceæ.

FIG. 198.—DULCAMARA.

FIG. 199.—ERYTHRÆA.

The Lauraceæ, once again, are distinguished in part by their single perianth—with features, however, in addition, so remarkable that no order is more easily defined. The plants composing it are, without exception, ligneous, many becoming trees of considerable dimensions. The leaves are simple, undivided, usually entire, and evergreen. The insignificant flowers are generally tetramerous, with few stamens, the anthers of which open by means of *lateral valves*. Aromatic juices are found in nearly every species, so that the smell alone is very often suggestive of the order our tree belongs to. Foremost in the glorious phalanx stands the bay, well named *Laurus nobilis*, the true, old original "laurel" of the poets, the tree dedicated to Apollo, and which for 2,500 years has furnished the materials for the chaplets that signalize victory. This admirable tree, the leaves of which when rubbed and bruised give the smell of cinnamon, is a native of Palestine and the southern parts of Europe. Hence, though in severe winters it rather suffers, in England it mingles with the favourites of every good garden and plantation, shining and refreshing the eye all the year round. That the name of laurel should have been transferred to the species of cherry to which it is now commonly given, is a pity, since the latter has none of the good qualities of the original, and on the contrary is poisonous. The bay is the only European species. The others belong chiefly to warm countries, and from these we derive several of the most esteemed varieties of spice, —cinnamon, for instance, and cassia. The flowers of these two last remind us slightly of white lilac. Camphor and gum-benzoin are products of other tropical species. Sassafras thrives in temperate countries, but as a whole the order must be considered one of those that love the utmost fervour of the sun. Camphor does not ooze from the tree. The atoms are embedded, so to speak, in the very

The Lauraceæ.

substance of the wood, which is cut up into small chips and then subjected to a kind of dry distillation. The camphor rises in the form of vapour, and condenses upon the straw which forms the roof or lining of the distilling-oven. Cinnamon and cassia may easily be distinguished. The former when broken across gives many fine projecting splinters. Cassia breaks short off like sealing-wax or slate-pencil. Cinnamon, it is hardly necessary to add, has a far more delicate flavour than cassia, which is strong and a trifle bitter. The very curious mode of dehiscence of the anthers in the Lauraceæ has few parallels: hence the value of this apparently trifling feature in establishing the diagnosis of the order. The Lauraceæ, in a word, are the only apetalous exogens in which it has hitherto been observed.

FIG. 200.

IN A GOOD TEMPER.

BY THOMAS DUNMAN.

ONE of the greatest advantages it is possible to possess is that of a good temper, which heightens the enjoyments of life and robs its griefs and disappointments of half their sting. It is far too commonly supposed that nature is alone responsible for the numerous inequalities of temper which the human family displays. This is, however, by no means a just complaint. Without doubt dispositions and temperaments do naturally vary, and, as in constitution and mental gifts, the great law of heredity is an important factor in determining the equability or otherwise of the temper which any particular individual displays. Nevertheless a very great deal may be effected by education and moral control. No person ever yet entered the world with a temper so amiable that it might not be made more so, and no one possesses a temper so bad that it may not be greatly improved. As a proof of the latter part of this statement it is only necessary to remind our readers that many persons who have been noted for their amiability have been naturally endowed with an extremely irascible temperament.

One of the habits which conduce most to an equable temper is that of taking just views of life and of our own position in it. By taking, on the one hand, too roseate views of life, we are apt to expect too much from those around us. This leads to frequent disappointment, and consequent exacerbation of temper: we are irritated to find our fellow-men so much worse than we thought them, and lose our temper when their actions are not in strict accordance with the high standard which we have set up. Let us remember that "to step aside is human," and especially is it human to deviate in small matters from the right track. Much more annoyance is caused by petty spite and malice, or petty pilfering, than by graver delinquencies; and it is well to guard our temper from injury by the numerous instances of these which we are sure to meet.

On the other hand, by taking a too gloomy view of life our temper soon grows sour and irritable, and we are apt to degenerate into morose misanthropes, unbearable alike to ourselves and others. The faculty of making the best of everything is a great assistance in the worries and anxieties of life, and all would do well to cultivate it.

A fruitful source of ill-temper is the habit of unlimited castle-building in the air. It is useless to rail indiscriminately at this common mental exercise, and it is doubtful if it would be altogether wise to entirely abolish it, even if it were at all possible. Some of the grandest achievements of the human intellect have been the result of day-dreaming of the wildest description, if we take into account the extreme improbability of their ever being realised which existed at the time when they first began to assume shape. But although we cannot altogether get rid of the habit, we may greatly restrain it. To build castles in the air which we know for certain can never be erected in a more substantial form is foolish and wrong, nor should we in any case allow our castle-building to interfere with more important concerns; if we do so, loss of temper is sure to ensue.

It is very important to avoid what is known as "techiness." Some people seem born with such a thin moral skin that you are always on tenterhooks while in their company for fear of unconsciously doing or saying something which may give them an excuse for the display of ill-temper. Where such a disposition exists the utmost watchfulness should be maintained, and however difficult it may be at first to shake it off, success will come at last.

It is a great acquisition when a thoroughly equable temper exists. Some individuals are notoriously uncertain in this respect,—one never knows how to take them. At one time they are all affability, and at another you can scarcely extract a word from them, either pleasant or otherwise; and these opposite moods succeed each other with astonishing rapidity. This disposition should be carefully guarded against. It is of course impossible to be always in precisely the same mood, as circumstances will sometimes occur to ruffle the sweetest temper and to depress the most sanguine. But these occasional variations in mood are quite different from the caprices of an uncertain temper.

One of the most odious forms of ill-temper is the sulky disposition. Better to be hasty than to nurse your anger and refuse to allow yourself to be propitiated. No better maxim can be given than the well-known command "Let not the sun go down upon thy wrath." However great the provocation, it is sinful as well as foolish to refuse to be reconciled when offence has been given. Temper, good or bad, has two influences—one reflex, affecting one-

self, the other direct, and affecting others. This is well seen in a sulky temper. To brood over injury and nurse wrath enormously aggravates the original annoyance, and heaps upon one's own head a terrible punishment. But the sulky individual not only renders himself supremely unhappy; the malign influence of his evil temper spreads like a blight on all around. Of all the forms of ill-temper, sulkiness is without doubt the most hateful; and we would earnestly advise those who have a tendency to its display to make a most determined effort to rid themselves of so disagreeable a monster. The main cause of sulkiness is generally a mistaken pride. It is thought to be unmanly and weak to forgive too easily a fancied injury, and stubborn pride is counted in such a case a commendable virtue. "It is manly," you say, "to resent an affront." True, *too* manly; but it is God-like to forgive.

A hasty temper is frequently the cause of much misery and self-reproach. Not a few lives have been entirely blighted by giving way to hasty temper; and even when less disastrous effects have been the result, a large amount of unhappiness has been produced. Those who give way to a hasty temper are nearly always in "hot water," they never can keep friendly with any one long, and you never know when to trust them, for just when they are all smiles and pleasantness they are most likely to fly into a passion over some trifling affair. This hasty temper usually indicates an impatient and irritable disposition, and no amount of watchfulness will in such a case be found too great to prevent its ill effects. Nevertheless it is the part of the brave and manly to struggle against such a tormentor, and they may feel encouraged by the thought of the unhappiness its conquest will save both themselves and others.

Few individuals make themselves more thoroughly disagreeable than the contentious person. The individual in question can never allow a statement to be made or an opinion to be expressed without immediately endeavouring to prove its fallacy. This by no means arises from a supreme love of truth, but from an unpleasant habit which has its root in extreme self-conceit. Solomon of old said, "Only by pride comes contention," and the maxim is good for all time. It is extremely irritating to be in the company of a contentious person, and every effort should be used to avoid contracting the habit of contradiction. It is not always necessary or politic to oppose opinions which run counter to our own, unless the exposition of such opinions is directly addressed to ourselves; still less is it necessary constantly to thrust our own before the notice of others. It is far better to yield a point which is not vital than to acquire a reputation for being contentious.

A kind of temper which it should be the aim of every one to cultivate is a cheerful one. A person possessed of a cheerful and pleasant disposition is of inestimable benefit in the world, and is the cause of an immense amount of happiness. When such a person enters a room it is like a beam of golden sunshine casting its pleasant rays on all around; when such an one is met it is like taking in a full draught of pure, invigorating mountain air. To cultivate this happy disposition it is necessary to avoid worrying too much about the inevitable trials and crosses of life, and to dwell but little upon the possibilities of evil which lie hidden in the future. While taking every precaution to ensure a prosperous future, do not worry yourself about what may happen (and just as possibly may not), to thwart your plans.

To ensure an equable and placid temper, nothing is more effectual than a clear conscience. The man who to the best of his ability endeavours faithfully to do his duty is the man who is least likely to be ill-tempered. On the contrary, a conscience which refuses to acquit its owner of blame, and before whose bar arraignments are constantly being made, is a goad which will provoke to unevenness and irascibility of temper.

Finally, we would advise those who desire to avoid lapsing into habits of bad temper to be careful of their health. A very great deal of the ill-temper in the world arises from defective digestion, or from some equally painful physical disorder. The irritability of a person suffering from the gout or from a bad toothache is proverbial; and, strange as it may seem, it is nevertheless perfectly true that to preserve your temper it is necessary to preserve your health. You cannot have a perfectly sound mind in an unsound body. Nevertheless, invalids have no right to exhibit bad temper and inflict annoyance upon others, because they are suffering or inconvenienced. The temptation to do so is doubtless very great, but it must be borne in mind that those around us are not answerable for our ill-health, and that it is moreover foolish to annoy those who may be induced thereby to withdraw their sympathy from us. We may be inclined to think ourselves of but little use in the world, but suffering nobly and patiently borne does good service in the cause of morality, and loses half its sting. The grand example of Milton in his blindness should be always borne in mind, and his noble resolution amidst his great affliction should check every murmur and complaint:

> "I argue not
> Against Heaven's hand or will, nor bate a jot
> Of heart or hope; but still bear up and steer
> Right onward."

XI.

Triangle of Forces.

§ 49. The manner in which we may pass from the plan of fig. 24 to the diagram of fig. 23 has already been indicated. But it is worth while to notice that we may from a given set of forces form several diagrams very different in appearance. For instance, fig. 25 is a diagram precisely equivalent to that in fig. 23, although its form is so different. This will most easily

be seen by drawing a plan, which will be found to be merely a reproduction of that in fig. 24. The importance of this power of varying the diagram is that we can often save much trouble and risk of error by choosing a convenient diagram. For instance, if any of the forces are parallel, we may take them together: the calculation of the resultant of these is a simple adding up first of those in one direction, then of those in the opposite direction, and the difference of these two sums gives the magnitude of the resultant. The simplification thus introduced has been utilized to a great extent by means of an artifice we shall now explain. We have seen that we can find one force which is equivalent to two given forces. The converse is equally easy, and, what is more, it can be done in an infinite number of ways. For instance, we can find two forces acting in *given directions*, equivalent to any proposed force. If it is required to resolve (as it is called) the force represented by AB (fig. 26) in given directions, we draw straight lines (one through A, the other through B) in the given directions. If C be the point where the lines meet, AC, CB represent two forces equivalent to AB—and they are in the required directions. If we have several forces to deal with, we can resolve each of them along two (or it may be in some cases three) directions. For example, if all the forces acted on the level we could resolve them *north* and *east*, but if there were upward or downward forces as well, we should be compelled to resolve in the three directions, *north* and *east* and *vertical*. Having thus resolved, we have only to take the sum of the forces along the north line, of those along the east line, and of those in the vertical. If all of these sums vanish there is equilibrium, except in the way of rotation,—otherwise not. This method is, as we have said, much used when mechanical calculations have to be made, but for our present purpose the method of §§ 45, 46 will be preferable. We will formally state the principle for the case of three forces, leaving to our readers the general case. We premise that in making a triangle with three lines we must alter neither the length nor the direction. Moreover, in the matter of direction attention must be paid to the arrowhead indicating in which of two opposite directions the represented force acts. Here, then, is the statement of what is commonly known as the "triangle of forces":—

Resolution of forces.

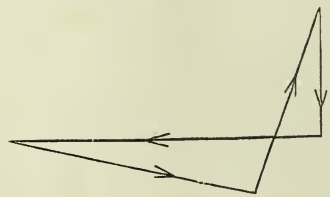


FIG. 25.

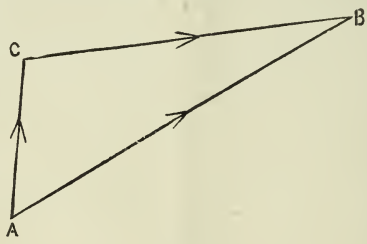


FIG. 26.

If three forces be in equilibrium, the lines that represent them in direction and magnitude can be made into a triangle. And conversely, if the lines representing three forces acting on a particle can be made into a triangle, these forces are in equilibrium.*

"Triangle of forces."

§ 50. The first application we will take shall be the inclined plane. A drayman raises heavy casks into his dray by means of a ladder or pair of rails sloping down to the ground, and by its help he is enabled to cart casks which, unaided, he could not lift an inch. Let us see whether we cannot discover the reason of this.

In fig. 27 we show an inclined plane in section, with a body, K, resting upon it. The first thing we must do is to find out what are the forces acting upon this body. For one thing there is its weight; this acts straight down, and we may be supposed to know how great it is. Next there is the force employed to keep it from rolling down the plane. This may be represented in direction by the line we have drawn up the plane, but we do not know how great it is. Lastly we have the resistance of the plane. If the plane were soft the body would sink into it, and as we suppose this does not take place, we must allow that there is some force which prevents the body moving into the plane. As to the magnitude of this force we know nothing yet; but we can easily get some information as to the direction. We shall suppose for the present that the plane is quite smooth, for it is easier to take account of friction by itself. Then the resistance of the plane will not hinder the body moving along it in any direction; so that this resistance must act perpendicularly to the plane: it must not lean to one side or the other of the plane. Thus what we know of the forces amounts to this: their directions are those indicated in fig. 27, but we only know the magnitude of one—namely, the weight.

The inclined plane.

We know, however, that these forces are in equilibrium, for our question is, How great must be the force that will just keep the body at rest? And now we can apply the first portion of the "triangle of forces." As the forces are in equilibrium, we know that the lines representing the forces can be made into a triangle. Let us do this. First we draw AB straight down, and of such length that it represents the weight of the body upon our chosen scale. Next we will put in the line that represents the force acting up the plane. If we draw this from A it must be put upon the left, as otherwise it would be going round the triangle in the opposite direction to AB. If we draw it from B it must be drawn on the right. The latter is the plan we will adopt. We know the direction

* The words "acting on a particle" simply imply that we do not take into account any rotary motion that may be produced.

in which to draw B C, but we don't know how long to make it; so we will leave the length undetermined for the present. From A we can draw a line (to the right) representing the resistance of the plane. This must be in the same direction as that resistance, but we are ignorant as to the length of it. But if you have drawn this figure as described, you will find that the three lines make a triangle A B C if we take B C, C A to be of the proper lengths: and thus by simply measuring these lengths we can tell the magnitudes of the two forces in question.

There is a very important property of the triangle we have just drawn, which you can easily prove for yourself if you know something of geometry. The property is that the new triangle is just the same shape as the side of the inclined plane.

The side A B corresponds to the slope of the plane, B C to the height, C A to the base. And it easily follows—(it will be well to work this out fully)—that the force P is the same fraction of the weight of the body as the height of the plane is of the length; and that the resistance, R, is the same fraction of the weight as the base of the plane is of the length. Suppose, for example, an inclined plane is 14 feet long and 2 feet high: the height is $\frac{1}{7}$ of the length, and the force required to keep a body at rest is just $\frac{1}{7}$ of the weight of the body—leaving friction out of account.

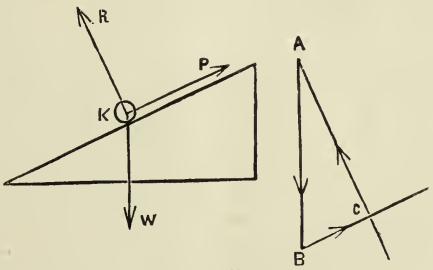


FIG. 27.

§ 51. The results of the last paragraph are useful in cases where friction has to be taken into account, and they furnish a simple means of finding coefficients of friction—namely, that given in § 37. If we find that a body will rest on a plane the height of which is just $\frac{1}{7}$ of its length, but begins to slip down when the plane is raised, then we know that the force keeping it at rest was $\frac{1}{7}$ of the weight. In this case, then, the coefficient of friction would be $\frac{1}{7}$.

Friction.

It is to be remembered that this friction always opposes any motion of the body along the plane, and it may be well to illustrate this by an example. Consider a body on a plane rising 1 in 3, and suppose that the coefficient of friction is $\frac{1}{4}$. For convenience of calculation we will take the weight of the body to be 21 poundals. Then we know that to keep this at rest on a smooth plane a force of 7 poundals acting up the plane is required. The friction is 3 poundals. Let us examine the effect of a force of 9 poundals acting upwards. It will not move the body upwards, for when the body moves upwards it has a drag of 2 poundals in addition to the 7 poundals due to its weight. Neither will it make the body move downwards. Suppose we had 5 poundals acting up the plane. This force is clearly insufficient to move the body up; but it is more than enough to keep it at rest. For if the body were to move downwards its weight would contribute 7 poundals, of which 3 would be used up in overcoming friction. The remaining 4 poundals are more than balanced by the 5 poundals acting upwards. It thus appears that the question What force will keep a given body at rest on a given rough inclined plane? is one which has several answers. In the case considered above, *any* force not less than 4 poundals nor greater than 10 poundals acting upwards would be an answer. The simplest process for determining whether a given set of forces will cause motion, is to find their resultant. If this resultant is less than the friction there will be no motion. If greater, the difference will give the effective resultant.

It is a convenient place here to draw attention to the necessity for care in making corrections for friction by adding a weight. This is only allowable when the resulting motion will only take place in one direction. If motion were observed in both directions and friction had been corrected for one, then in the other the error would be doubled. The correcting weight must always act so as to assist the motion which takes place or is on the point of taking place.

Other examples.

§ 52. There are a whole host of instances arising in daily life in which a knowledge of the principle of the triangle of forces can give valuable information. These cases may be treated just like the inclined plane. Take, for instance, the forces that act on the head of a crane. There is the pull of the chain that supports the load, the thrust of the jib and the pull of the tie-rod which prevents the jib falling forwards. We know the directions of these forces and the magnitude of one of them, and can therefore at once find out how great each of the others is. Similarly in the case of a beam slung by two chains, and other examples that will occur to our readers. But the information given by this important principle is not complete, and we shall in the next section of our articles show how to complete it by the consideration of rotary motion.

It will be useful to notice here some assumptions usually made in applying mechanical principles in practice. We have already seen that the force of resistance between two surfaces is at right angles to them, friction being for the moment neglected. Thus, when a ladder leans against a wall, the pressure between the ladder and the wall is horizontal. The direction of the pull of a string or a tie-rod is given by the direction of the string or rod. The direction of the force exerted at a hinge is not determinate. For example, the hinge prevents a door being pulled away from the doorpost, whatever the direction of the pull.

GERMAN.

XXXIX.

Exercise in Calligraphy.

(This Exercise should, if possible, be written from dictation, and then compared with the model here given.)

Als der berühmte Benjamin Franklin noch ein Jüngling von achtzehn Jahren war, besuchte er einst den Prediger Mather, in Boston. Dieser nahm ihn sehr liebreich auf und führte ihn beim Weggehen einen kürzeren Weg aus seinem Hause. Die Hausthür war aber so niedrig daß ein erwachsener Mensch sich bücken müßte, um nicht an den Querbalken zu stoßen.

Franklin sprach während des Fortgehens mit seinem leutseligen Führer und sah diesen nicht aufmerksam vor sich hin. "Gebückt! Gebückt!" rief auf einmal der Prediger; aber in dem Augenblicke stieß schon Franklin den Kopf an der Thüre. "Merke Er sich den kleinen Unfall!" sagte der Prediger. "Er ist jung, und hat die Welt vor sich. Bücke Er sich auf dem Wege und er wird sich manchen harten Stoß ersparen.

Diese Lehre machte bei dem jungen Franklin einen so tiefen Eindruck daß er sich ihrer in einem Alter von 79 Jahren noch erinnerte, und

Die Geschichte einem Besuch des verstorbenen Predigers erzählen, indem er hinzusetzen: "Dieser gute Rath Ihres seligen Vaters so in Kopf und Herz eingegraben, ist mir ungemein nützlich gewesen, und noch jetzt fällt er mir gewöhnlich ein wenn ich sehe wie der Hausmann sich unglücklich macht mit der Nase zu vorstehen.

English Version of the above, for Re-translation into German, after studying the German story.

When the celebrated Benjamin Franklin was still a youth of eighteen years, he once visited the preacher Mather, in Boston. The latter (this one)[1] received him (took him up) very affectionately, and led him at (his) departure a shorter way out of his house. The side-door was, however, so low, that a grown person was obliged to (must) bend (himself) in order not to strike against the crossbeam.

Franklin talked while going away with his gentle-spirited conductor, and locked therefore not attentively before him (away).

"Bend! Bend!" (literally bent! bent![2]) called all at once the preacher; but in that moment Franklin felt already the beam against his (the) forehead. "Remember for yourself (literally, 'Let *him* remember for himself,'—the third person used by an elderly man in speaking familiarly to a youth)[3] the little disaster," said the preacher. "You are young (third person form Er, continued), and have the world before you. Bend yourself on the way, and you will spare yourself many a hard bang."

This counsel made on the young Franklin so deep (an) impression, that he at the age of seventy-nine years still remembered it, and told the story to a son of the before-mentioned preacher Mather; while he added: "This good counsel of your deceased (literally beatified)[4] father, thus engraved in head and heart, has been uncommonly useful to me; and still now it generally occurs to me, when I see how high-mindedness is so often humbled, and how so many a one makes himself unhappy because he carries his (the) nose too high.

Notes.—1. Dieser and Jener are used in German like the French *celui-ci* and *celui-là*—dieser like *celui-ci* referring to the latter, the one nearest to the speaker.

2. In words of command, or in directions given as a matter of course, the past participle is often substituted for the imperative—Aufgestanden, stand up!

3. The form Er for the second person Du was formerly used in speaking to inferiors; and among people of the lower class in addressing familiar friends.

4. Die Seligkeit in German means the highest form of happiness—that of a beatified spirit. Therefore a deceased person is spoken of as „selig," or one who has entered into bliss.

XXXIX.

Compound Interest.

We have already explained what Compound Interest is. Of course the periods at the end of which the interest is to be added to the principal may be of any given length—half a year, three months, etc.; but unless the contrary is stated, the period will be assumed to be one year.

Case I.—*To find the interest or amount at compound interest when the principal, rate per cent., and time are given.*

From the explanation already given of the nature of compound interest, it follows that the following is the *Rule*:—

Find the amount of the given principal for the first period at simple interest: this amount will be the principal during the second period. Find the amount of this second principal for the second period at simple interest: this amount will be the principal during the third period. Continue this process till the amount for the last period is found. This last amount is the required amount of the given principal for the whole time at compound interest. The

whole compound interest is found by subtracting the given principal from the whole amount.

Example.—Find the compound interest on £250 for 3 years at 10 per cent. per annum.

Simple interest for 1 year $= £\frac{250 \times 10}{100} = £25.$

∴ amt. at end of 1st year = £275

interest for 2nd year $= £\frac{275 \times 10}{100} = £27\ 10s.$

∴ amount at end of 2nd year = £302 10*s.*

interest for 3rd year $= \frac{(£302\ 10s.) \times 10}{100} = £30\ 5s.$

∴ amount at end of 3rd year = £332 15*s.*

i.e. whole amount in 3 years = £332 15*s.*

given principal = £250

Compound interest for 3 years = £82 15*s.*

If the compound interest be required for any number of periods and a fraction of a period—*e.g.* for $4\frac{2}{3}$ years—it is usual to find the interest for the whole of the last period (*i.e.* for the fifth year), and then take the proper fraction ($\frac{2}{3}$) of that interest as the interest for that fraction of the last period.

The given rate per cent. in questions in Compound Interest is, unless otherwise stated, the rate per cent. *for a year.* If therefore the interest is payable at periods of less than a year, we must remember that the rate per cent. for that period is proportionately less. For instance, in the last example, if the interest were payable every half-year, the rate per cent. per period would be 5 instead of 10, and we should have to find the amount for six successive periods at the rate of 5 per cent. instead of for three periods at 10 per cent.

The student will easily see that the shorter the periods at which interest is payable the larger the Compound Interest will be.

The rules of Compound Interest are, in fact, only particular applications of the principles of Simple Interest; and a thorough comprehension of these principles will enable the student to work all ordinary examples in Compound Interest.

It is generally most convenient to work with decimals when there are more than two periods.

Case II.—*To find the principal when the interest (or amount), the rate per cent., and the time are given.*

When the rate per cent. and the time are given, the compound interest is directly proportional to the principal. Hence

Compound interest on £1 : given compound interest : : £1 : required principal;

$\therefore$ required principal $= \frac{\text{given interest}}{\text{interest on £1}}$;

i.e., the principal is found by dividing the given compound interest by the compound interest on £1 for the given time.

The amount is also proportional to the principal. Hence

Amount of £1 : given amount : : £1 : required principal;

$\therefore$ required principal $= \frac{\text{given amount}}{\text{amount of £1}}$.

Exercises.

I. Find the amount at Compound Interest of the following :—

1.	£451	for 2 years	at 3	p. c.	per annum
2.	£91 17*s.* 6*d.*	„ 4	„ 7	„	„
3.	£1959 15*s.*	„ 3	„ $2\frac{1}{2}$	„	„
4.	£1512 6*s.* 8*d.*	„ 2	„ $3\frac{1}{4}$	„	„
5.	£3926 18*s.* 4*d.*	„ 3	„ 5	„	„

II. Find the compound interest in each of the last set of exercises.

III. 1. Find by how much the amount of £831 in 4 years at $2\frac{1}{4}$ per cent. compound interest exceeds the amount in the same time at the same simple interest.

2. Find the difference between the simple and compound interest on £21 10*s.* in 4 years at 5 per cent. per annum.

3. If the simple interest on a shilling for 1 month be a farthing, what is the rate per cent. per annum (Simple Interest)?

4. A merchant owes £4250. It is agreed to let the debt stand for $2\frac{1}{2}$ years at 5 per cent. per annum Compound Interest. What sum will be sufficient to discharge his debt at the end of that period?

5. Find the difference between the simple and compound interest on £955 at 6 per cent. for 4 years.

Answers.

I. 1. £478 9*s.* $3\frac{1}{2}$*d.*
2. £120 8*s.* 7*d.*
3. £2110 8*s.* $8\frac{1}{4}$*d.*
4. £1612 4*s.* $7\frac{1}{2}$*d.*
5. £4545 17*s.* $11\frac{1}{4}$*d.*

II. 1. £27 9*s.* $3\frac{1}{2}$*d.*
2. £28 11*s.* 1*d.*
3. £150 13*s.* $8\frac{1}{4}$*d.*
4. £99 17*s.* $11\frac{1}{2}$*d.*
5. £618 19*s.* $7\frac{1}{4}$*d.*

III. 1. £2 11*s.* 3*d.* (nearly).
2. 6*s.* 8*d.* (nearly).
3. 25 per cent.
4. £4802 15*s.* $3\frac{3}{4}$*d.*
5. £21 9*s.* $3\frac{1}{2}$*d.* (nearly).

Present Worth and Discount.

Suppose I have agreed to pay a certain sum of money, say £1000, at some future time, say 6 months hence; and if instead of waiting for that time I agree to pay the debt in full at once, it is clear that I lose 6 months' interest, and my creditor gains what I lose. To make the transaction a perfectly fair one, commercially, he ought to make an abatement in my favour equivalent to the 6 months' interest, which I lose and which he gains. Instead of my paying him in full, he ought to take only such a sum as together with the interest on it for 6 months will amount to £1000. This sum which I ought to pay now instead of paying £1000 6 months hence is called the "*Present Worth*" of £1000 due 6 months hence.

The abatement which my creditor makes in my favour is called "*Discount.*" Clearly the discount ought to be equal to the interest on the present worth.

Let us consider the following simple case. Suppose that instead of being paid £1040 a year hence, I wish to get paid at once, by an immediate payment down : how much ought I to require at present as an equivalent to being paid £1040 a year hence? Evidently I ought to be paid such a sum as, with interest thereon, will a year hence amount to £1040. The question depends therefore on the rate of interest at which the abatement is to be calcu-

lated ; in other words, it depends on the rate of discount. Suppose that the rate agreed upon is 4 per cent. per annum. Now, £1000 would in a year, with interest at 4 per cent. per annum, amount to £1040. Clearly therefore £1000 is the present equivalent of £1040 a year hence. Or we may say that the present worth of £1040 due a year hence, discounted at 4 per cent. per annum, is £1000, and the discount on £1040 due a year hence, at 4 per cent. per annum, is £40. We can now understand the following definitions :—

The *present worth*, or *present value* of a sum of money due at the end of a given time, is the sum which together with its interest for the given time will amount to the sum due.

Discount is the interest for the given time on the present worth.

Discount (also) is the difference between the sum due and its present worth, *i.e.*,—

D. = Sum due − P. W. ;
or, D. + P. W. = Sum due ;
or again, P. W. = Sum due − D.

To find the present worth of a given sum due at any given time, at a given rate per cent. per annum.

Rule. — Find the amount of £100 at the given rate per cent. for the given time ; then state as follows :—

Amount of £100 : given sum : : £100 : P. W. of given sum.

For the given sum is, in fact, the *amount* of the required P. W., and the amount for any given time and given rate is directly proportional to the principal from which it arises. The first two terms of the above proportion are "amounts," and the other two terms are the corresponding "present worths."

PLANTATION OF SUGAR-CANES.

Example 1.—Find the present worth of £816, due 6 months hence, at 4 per cent. per annum.

Interest on £100 for 6 months, at 4 per cent. per annum, = £2. ∴ following the statement, we have,

£102 : £816 : : 100 : P. W. of £816 ;
from which we find, P. W. of £816 = £800,
and discount = £16 (*i.e.* sum due − P. W.)

Example 2.—Find present worth of, and discount on, £530, due 9 months hence, at 8 per cent. per annum.

Int. on £100 at 8 per cent. per annum for 9 months = ¾ of £8 = £6.
∴ Amount of £100 = £106.
∴ £106 : £530 : : £100 : P. W. of £530.
∴ P. W. of £530 = £500,
∴ discount = £30.

Example 3.—Find present worth of £1624, due in 61 days (of leap year), at 9 per cent. per annum.

Int. on £100 for 61 days (of leap-year) = $\frac{61}{366}$ of 9 = £1½ ;
∴ £101½ : £1624 : : £100 : P. W. of £1624 ;
from which we find,
P. W. = £1600,
discount = £24.

We may find the discount directly, *i.e.* without first finding the P. W., as follows :—

Since discount is the interest on P. W., and is therefore also directly proportional to the sum discounted, we have the following rule of three statement :—

Amount of £100 : given sum : : interest on £100 : discount on given sum from which discount can be found.

This statement may be expressed in different language, as follows :—

£100 + interest on £100 : (P. W. + discount of given sum) : : interest on £100 : (discount of given sum).

Example. — Find discount on £1430, due 3 years hence, at 3⅓ per cent. per annum simple interest.

Amount of £100 for 3 years at 3⅓ per cent. per annum = £110.
∴ £110 : £1430 : : 10 : D.

$$D = £\frac{1430 \times 10}{110} = £13$$

In our next lesson we shall begin with a series of examples in which, it is to be observed, simple interest is charged—not compound. We may as well add that in our calculations fractions of a farthing have been generally neglected. It is only in exceptional cases that these fractions are of consequence.

XXXVII.

SUGAR.

THE term sugar may be applied to any sweet substance of organic origin. Thus the sweet principle of manna, of liquorice, of the nectar of plants, and of milk, is sugar. We propose, however, to speak of two kinds only—namely, glucose or grape sugar, and cane sugar ; the latter being, commercially speaking, by far

Different kinds of sugar.

the more important and valuable. Although usually obtained from a plant belonging to the natural order of the graminaceæ or grasses growing in most tropical regions, and commonly known as the sugar-cane, a similar saccharine matter may be extracted from the maple, the root of the beet, and from many other esculent vegetables. The stem of the Indian corn, of wheat and other cereals, and even of our own natural grasses, all contain a greater or less proportion of sugar, as any one may convince himself by chewing a portion of the stalk when young and tender.

Glucose and cane sugar.

Cane sugar in vegetables.

Glucose or grape sugar, met with in the grape and many other fruits, is sometimes denominated uncrystallizable sugar. The term, however, is incorrect: it crystallizes without difficulty, but its crystals have not the coherence and hardness of those of cane sugar. Small portions of this sugar may frequently be found adhering to dried grapes or raisins. This is the sugar that is produced by the action of diastase on starch. Its sweetening properties are very inferior to those of cane sugar.

Grape sugar or glucose.

Less sweet than cane sugar.

The juice of the sugar-cane, almost the only source whence the sugar used in this country is obtained, is expressed by crushing the stems under the rollers of what is termed a sugar mill. The sweet transparent juice thus obtained must not be left to stand long, as in the high temperature of the tropics it would soon ferment, the sugar would undergo the transformation already spoken of into alcohol, and the result would be the formation of a spirituous and intoxicating liquor instead of sugar. It is necessary, therefore, that the process of crystallization should commence without delay. The juice of the cane is first heated in boilers to the temperature of about 140° Fahrenheit. Milk of lime—quicklime and water—is now added, care being taken not to allow the mixture to boil. A thick scum soon rises to the surface, which is not removed, however, until it begins to crack—an indication of the completion of this portion of the process. The crust of impurities is now skimmed off the surface, or the clarified juice is removed from under it by a sluice. It is next allowed to evaporate in shallow metal pans, in which the crystallizable portion of the sugar separates from the non-crystallizable portion, which latter is allowed to drain from under it, leaving behind the raw or moist sugar, as we term it, in the state in which it is exported into this country. The portion of the sugar which refuses to crystallize is known as molasses.

Manufacture of sugar.

Formation of alcohol.

The heating process.

Formation of scum.

The juice allowed to crystallize.

Molasses.

The final conversion of the raw sugar, or muscovado, as it is termed in commerce, into loaf sugar, is a more scientific process, which consists in getting rid of the colouring matter and other impurities in the sugar, and allowing the refined residuum to crystallize in moulds. A strong solution of raw sugar is first heated in boilers, and a certain quantity of bullock's blood is added, which, rising to the surface as its albuminous portion coagulates, brings with it many impurities. All traces of colour in the liquid are finally removed by the action of what is termed animal charcoal, obtained by the partial combustion of the bones of animals. The solution is next boiled in what is termed a "vacuum pan," under greatly diminished atmospheric pressure, which promotes rapid evaporation and prevents the boiling liquid from attaining to too high a temperature. As soon as the inspissated and now viscous syrup will draw into threads, it is removed into what are termed the "coolers," and subject to a mechanical process tending to promote crystallization, which is finally effected in conical earthen moulds, from the apex of which the fluid, uncrystallizable portion of the sugar, is allowed to drain. The loaves of sugar, as they are termed, are now removed from the conical moulds, and after being shaped or trimmed, and thoroughly dried, are fit for use.

Muscovado.

Manufacture of loaf sugar.

Purification by albumen.

Animal charcoal.

The vacuum pan.

Crystallization in moulds.

Such, in brief, is the method employed to convert raw or moist sugar into white or loaf sugar. We have next to consider the conversion of sugar into alcohol, as exemplified in the manufacture of wine and other intoxicating drinks, and in the process of brewing and distillation. Before doing this, however, we must define what is meant by

Conversion of sugar into alcohol.

Fermentation.

This term is of very wide application in the present day, being used in speaking of those changes which organic substances undergo, which come under the general designation of putrefactive changes. We shall for the present confine our attention to vinous fermentation, or the conversion of glucose into alcohol and carbonic acid. Just as a medium, such as sulphuric acid or diastase, is required to effect the conversion of starch into sugar, in like manner we find that an agent is needed to set up the action of fermentation. It has justly been remarked that a solution of pure glucose or grape sugar would never ferment of its own accord, but the addition of any slowly decomposing albuminous substance, such as white of egg or yeast, at once suffices to induce fermentation. Now, in point of fact, the whole of the natural vegetable juices, whether derived from the grape or other fruits, which we allow to ferment, contain within themselves sufficient albuminous substance to set up the action of fermentation spontaneously.

Meaning of fermentation.

Vinous fermentation.

Pure glucose will not ferment.

Vegetable juices contain a ferment.

The juice of the grape, or must, as it is termed when first it flows from the wine-press, is a turbid liquid, holding a number of different substances in solution, the chief of which are glucose, starch, gluten, albumen, tannin, and colouring matter, together with the salt bitartrate of potash, commonly known as tartar. A small quantity of essential oil, derived chiefly, in all probability, from the seeds and skin of the grape, imparts an odour or bouquet to the wine.

Wine must.

Substances held in solution.

The alcohol of wine is of course derived from the grape sugar or glucose in the must, the action of fermentation whereby this transformation is effected being due to the presence of the albumen already spoken of; the strength of the wine being in the proportion of the quantity of sugar contained in the juice of the grape, or at least of that portion of it which has been converted into alcohol by fermentation. In sweet or fruity wines a large portion of the sugar is retained unchanged, whilst in a dry wine nearly the whole has undergone this transformation. The proportion of sugar in the original must may be judged of by its density: we may say, therefore, that the greater the weight of the juice of the grape the greater the strength of the wine. It not unfrequently happens, in cold and wet seasons, that the amount of glucose developed in the grape is too small to give rise to a sufficient amount of alcohol in the wine. Under these circumstances glucose, or cane sugar converted into glucose, is added to the fermentable liquor, in order that the wine may be brought up to the requisite degree of strength. This is far superior to the direct addition of alcohol in the form of brandy. It is to be observed that in the manufacture of wine no yeast or other ferment is added to the natural juice of the grape, as the latter contains within itself an albuminous compound which enters into vinous fermentation at a sufficiently high temperature. It may be asked, how is it that the juice of the grape does not ferment and give rise to the formation of alcohol in the grape itself? The answer to this is that the juice under these circumstances is protected from coming into contact with the atmosphere by the skin of the grape, the action of fermentation being set up by the direct action of the oxygen of the atmosphere upon the nitrogenous compound which acts as the ferment. The œnanthic ether or odorous bouquet of the wine is developed in the process of fermentation.

Strength of wine proportionate to the quantity of sugar in the must.

Sweet and dry wines.

Glucose added to the juice of the grape.

Natural ferment in wine.

Why wine does not form in the grape.

Bouquet of wine.

The colouring matter of wine is derived chiefly from the skin of the grape. White wines are the product of grapes which contain little or no colouring matter.

Colour of wine.

THE BAR.

I.

WE think that a paper on the Bar is likely to be useful to two classes of persons. To those who may be about to rush into that profession without due consideration, it will, we trust, be a warning to pause and "count the cost"; while those who have deliberately chosen this career will find here some little help and guidance. In the remarks which we are going to make by way of warning, we must premise that we suppose ourselves to be addressing persons of average strength of character and power of making head against difficulties. To those who are distinctly above the average in these respects, our warnings will not be discouraging, but will, we trust, enable them to see more clearly the arduous nature of their life task, and brace them up for a long and strenuous effort. A young man's career at the Bar must, under the most favourable circumstances, be one of unflagging effort—severe but yet invigorating to a robust Briton, and ultimately triumphant; under unfavourable circumstances it will be one of constant difficulty and discouragement, in which the fear of ultimate failure will, for some years at least, be ever present, and all the courage in the man's character will be needed. We shall state very briefly what we consider the essential conditions of a moderately happy and prosperous career for a young man of average abilities about to become a law student, and hereafter a practising barrister living by his profession. In the first place, can he afford it? Has he the means of defraying the necessary expenses over and above the means of living? We shall say nothing about the latter, because every one can determine for himself the question of living. But supposing the student provided for in this respect, can he meet the demands which his profession will make on his purse? These demands may be approximately set down at £400, spread over three or four years of his student life, and from £50 to £150 a year afterwards. Against this annual expense of £50 to £150 may be set off any professional earnings which he may win; but in most cases it is not safe to count on any such set-off for five or six years, or more, and even then they will probably be small.

The next condition is that the student should have the requisite qualities of mind, character, and even bodily health. He must have, at the very least, good average abilities and education; fortitude to persevere in the face of disappointed hopes and unlooked-for discouragements; determination to carry him through uninteresting work; and health to stand the strain of severe and long-continued study. Besides these qualifications, it is almost a necessity that he should be able to speak clearly and reason closely. It is certain that unless he possesses or can acquire

these faculties, he will never be a brilliant success.

The third grand question for the student is, has he any connection on which he can rely among solicitors? Can he count on being supplied with work by friends or business connections?—for it must be remembered that a barrister without work is like a doctor without patients. He not only gets no fees, but he gets no experience—no opportunity of learning and practising himself; and it is almost certain that strangers, or even acquaintances, unless in some way bound to stand to him through thick and thin, will not give work to an inexperienced young man. He is in a dilemma; for no one will give him work while he lacks experience, and he cannot get experience except by work. And a barrister cannot, like a solicitor or doctor, buy a practice: he must make it for himself—and make it out of nothing. His difficulty is somewhat like that of the Israelites of old when they were desired to make bricks without straw. Undoubtedly, ultimate success may be, and in a vast number of cases is, attained where this third condition of success does not exist. But though not absolutely essential, its absence enormously increases the difficulties and trials of a young man's career, and in many cases proves fatal.

To some extent, this third condition is an alternative to the first,—that is to say, that with a strong connection which can be relied on, one is not so dependent upon private means; and, on the other hand, *with* private means one can hold out until by perseverance and diligence success is conquered. With one or other of these conditions fully satisfied, the young barrister's position is not so trying, and success is certain if he possesses the requisite qualities in himself. But trying indeed is the position of the newly called barrister who has neither money nor professional connection.

Assuming, then, that these three conditions—at all events the first two, viz., sufficient means and fit personal qualifications,—are fulfilled, success may be reasonably hoped for.

We now proceed to inform our reader of the various steps which he must take to become first a law student, and finally a full barrister-at-law.

Choice of an Inn.

The first thing to be done is to get admitted as a student of one of the Inns of Court. There are four of these—the Inner Temple, the Middle Temple, Lincoln's Inn, and Gray's Inn,—which in all essentials are similar, and any one of them will suffice as a door by which to get admission to the Bar. Formerly there were many more Inns of Court, but these four are all that now remain; and as our object is not historical, we shall confine our attention to them.

The regulations concerning admission to membership of any one of these Inns are published, and can be obtained by writing to the Treasury office of any of the Inns. We shall give extracts from them, but any intending student should write for a printed copy of the regulations. The first thing to be noticed is that there are a considerable number of occupations which render ineligible for admission to any Inn those who are actually practising them. The regulations say: "No Attorney-at-law, Solicitor, Writer to the Signet, or Writer of the Scotch Courts, Proctor, Notary Public, Clerk in Chancery, Parliamentary Agent, or Agent in any Court original or appellate, Clerk to any Justice of the Peace, or person acting in these capacities, and no Clerk to any Barrister, Conveyancer, Special Pleader, Equity Draftsman, Attorney, Solicitor, Writer to the Signet, or Writer of the Scotch Courts, Proctor, Notary Public, Parliamentary Agent, or Agent in any Court original or appellate, Clerk in Chancery, Clerk of the Peace, Clerk to any Justice of the Peace, or to any officer in any Court of Law or Equity, and no person acting in the capacity of any such Clerk, shall be admitted as a student at any Inn of Court until such person shall have entirely and *bonâ fide* ceased to act or practise in any of the capacities above named or described; and if on the rolls of any Court, shall have taken his name off the rolls thereof."

The object of these disqualifications is to preserve the tone and etiquette of the profession, and to keep it free as far as possible from the underhand influences which there is reason to fear might creep in. No doubt these conditions sometimes operate as a hardship on individuals, but they are considered necessary in the interest not only of the profession, but of the public, who are so dependent upon the probity and high sense of honour of those to whom their worldly interests are frequently committed almost blindly.

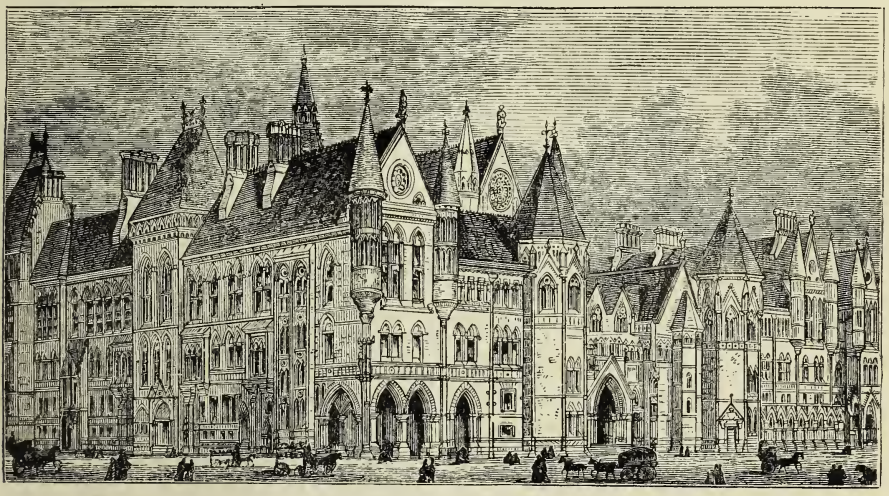
In addition to these restrictions, which apply to all the Inns of Court, Lincoln's Inn has imposed one of its own—viz., that the candidate must not be in trade.

The candidate must, before admission, either pass an examination in English (language and history) and Latin, before examiners appointed by the Council of Legal Education, or else produce a certificate that he has passed a public examination at *some* University. Neither test is very severe, the object being to ensure a preliminary education sufficiently liberal to form the groundwork of a "learned" professional education.

We have said that any of the Inns of Court may be used as a door by which to enter the Bar, and it is a matter of very little importance which the student selects. Yet there are some slight differences which it may be well to understand. We must premise that practice at the Bar is divided into two great branches: (1) Equity or Chancery, and (2) Common Law; and that those who practise in the one division rarely if ever have a case in the other. Now, it so happens that all Equity barristers have their business chambers in Lincoln's Inn, while all Common Law barristers have theirs in the Temple. Hence it is found more convenient for an Equity barrister to belong to Lincoln's Inn, and for a Common Law barrister to be a member of either Temple. It is by no means necessary to belong to the Inn in which your business chambers are situated, but it is advantageous in many little ways; for

instance, you can in that case get chambers in your own name direct from the Inn, instead of coming in as under-tenant to some other lessee; you are generally nearer to your own library, which you will have frequently to consult; and you are more brought into social contact with the persons whom you meet professionally. There are hardly any practical differences between the two Temples, and probably in deciding between them the student is influenced solely by the prospect of having some acquaintance at one.

As to Gray's Inn, it is separated from the others, and is some distance from the New Law Courts ; its chambers are not used for business by barristers; and the number of students is far below that of the other three Inns. This latter fact, however, gives an impecunious student a better chance of gaining one of the pecuniary prizes which are offered liberally by the Society; the fees are also rather smaller than at the other Inns. These are the only advantages which Gray's Inn possesses, so far as the writer knows, and they are only of advantage to the student who has to count the cost very carefully.



THE NEW LAW COURTS.

Admission Fees, etc.

Having chosen his Inn, the student must get from the Treasury office of that Inn a printed form of application for admission, for which he must pay one guinea, and which must be signed by himself and two barristers. There is no difficulty about procuring the necessary signatures if the student can get an introduction to any barrister.

The candidate for membership must also on admission pay certain fees, and in general deposit £100 as caution money, besides entering into a bond to secure whatever may hereafter become due on account of fees, dinners, etc. Members of a university are, however, generally exempted from the deposit of £100. This deposit is retained until the student is either called to the Bar or withdraws from the Inn, in either of which cases the balance (if any), after deducting what is due to the Inn, is returned.

Finally, the fees have to be paid—viz., a Government stamp of £25, a fee of £5 5*s.*, to admit to all lectures supplied by the Council, and some other small fees which vary at different Inns,—the total amounting to about £40.

To recapitulate:—the student may present himself at the Treasury office of any Inn for admission on any day, if he is duly provided with the following—viz., (1) Certificate of Examination ; (2) form of application for admission duly signed ; (3) deposit money (if required), and bond duly signed ; and (4) the amount of admission fees.

The student is now, we assume, a member of one of the four Inns. He is thereby at once entitled to attend certain law lectures free, to compete for many money prizes, to dine in hall during term, to rent rooms from his Inn, to use the chapel, gardens, and, above all, the library of his Inn, besides many other privileges ; provided only that he keeps his name on the list of members of his Inn, for which he pays a small fee varying from 16*s.* to £5 5*s.*

LATIN.

XXXIX.

The Syntax of the Dative Case after the Substantive and Adjective.

The dative after nouns substantive is used to mark *advantage* or *disadvantage*, and is accordingly called the *dativus commodi* or

incommodi: as *Mihi, et liberis, non aliis operor*, I work for myself and children, not for others. Here *mihi* and *liberis* and *aliis* are all datives, because they express the advantage or the interest of the persons specified.

In the poets the dative is used by a Greek idiom after a verb of *fighting* or *contention*, instead of the ablative with *cum*. as in *Luctantem Icariis fluctibus Africum mercator metuens*, the merchant, when fearing the south wind, wrestles with the Icarian billows. Here observe that *Icariis fluctibus* is the dative for the ablative case with *cum*.

The dative of the substantive often marks a *purpose*, or *result*, or *object*, and is used with verbs signifying to *be* or *become*, to *give*, to *send*, to *import* or *reckon*, as in *Est magno odio apud nos*, he is an *object* of great hatred amongst us. Often this dative of purpose or result is combined with the *dativus commodi* (dative of advantage) or *dativus incommodi* (dative of disadvantage), as in *Amplas domus sæpe* FIT DOMINO DEDECORI, a spacious house often becomes a disgrace to its owner. Here *domino* is the dative of advantage, or rather disadvantage, and *dedecori* the dative of *result*.

Sometimes the dative—especially in the case of the personal pronouns *mihi, tibi, sibi, nobis, vobis*—marks the *interest of the person* in the matter spoken of; and this is called the *ethical* dative, as in *Quid mihi Celsus agit*, I am concerned to know what Celsus is doing. Here *mihi* is in the dative case, because it marks the *interest* of the person.

The adjectives which govern a dative denote

1. Utility, as *utilis*, useful; *commodus*, convenient; *fructuosus*, very productive.

2. Injury or unprofitableness, as *noxius*, hurtful; *inutilis*, useless.

3. Fitness, as *aptus*, fit; *accommodatus*, fitted to; *idoneus*, suitable to; *proprius*, peculiar to; *congruens*, in harmony with.

4. Unfitness, as *incommodus*, not suitable to.

5. Acceptableness, as *gratus*, welcome to; *jucundus*, pleasant; *carus*, dear.

6. Unacceptableness, as *ingratus*, unwelcome; *injucundus*, unpleasant.

7. Friendliness, as *benignus*, generous to; *amicus*, friendly to; *benevolus*, well disposed to; *fidelis* and *fidus*, faithful to.

8. Hostility, as *inimicus*, hostile to; *perniciosus*, very destructive to; *malevolus*, ill disposed to; *malignus*, ungenerous to; *molestus*, troublesome to; *iratus*, angry with; *infestus*, a deadly enemy to.

9. Likeness and unlikeness, as *similis*, like to; *dissimilis*, unlike to.

10. Equality and inequality, as *æqualis*, of like (age), etc.; *inæqualis*, of unlike (age).

11. Proximity, as *finitimus*, very close to; *vicinus*, neighbour to; *propinquus*, near to.

12. Capacity, as *penetrabilis*, that can be penetrated.

Observe, too, that any adverb may govern a dative case if that adverb be derived from an adjective governing a dative case, as in CONGRUENTER NATURÆ *vivere est summum bonum*, it is the highest blessing to live in accordance with nature. Here observe that *naturæ* is the dative case because the adverb is derived from the adjective *congruens*, which governs a dative case. These adverbs governing a dative case are *utiliter, inutiliter, malignè, similiter*.

Observe (1) however, that some of these adjectives when used as substantives—as *amicus*, a friend; *inimicus*, a foe; *vicinus*, a neighbour—take the subjective *genitive case*, and not the dative: *Ille erat amicus Cæsaris*, he was the friend of Cæsar.

(2) Some adjectives of *fitness* and *utility* are sometimes constructed not with a dative, but with an *accusative* with *ad: Aptus ad eam rem*, fit for that thing.

(3) *Similis* and *dissimilis* sometimes take the *genitive* case, as *Decem similes Nestoris*, ten men like Nestor.

Mutual likeness is expressed by *inter* with an accusative case, as *Dissimiles sunt inter se fratres*, the brothers are unlike each other.

(4) Adjectives denoting *friendliness* are sometimes constructed with *erga* and *adversus* with an accusative case, as *Benignus erat erga me*, he was generous to me; but adjectives denoting unfriendliness are constructed sometimes with *adversus* and the accusative.

Exercises.

Translate into English:—

Turba gravis paci, placidæque inimica quieti. Hic puer est simillimus patri. Mors communis est omnibus. Nulli astro lucus erat penetrabilis. Servi erant domino bono benevolentissimi suo. Sis semper amici fidelis. Ille patriæ idoneus, agris utilis erat. Qui color albus erat, nunc est contrarius albo. Poeta magnus oratori magno est finitimus. Usum divitiarum inter homines esse æqualem volumus. Patria sola omnibus bonis cara esse videtur. Romulus multitudini gratior fuit quam Patribus. Deiotarus fidelis erat populo Romano. Idque eo facilius credebatur quia simile vero videbatur. Homo alienissimus huic civitati et moribus bonis erat. Ingratam Dîs pone superbiam. Siculi ad unum (*to a man*) Verri inimici infestique fuerant. Cui bono fuit? Pausanias, rex Lacedæmoniorum vēnit Atticis auxilio. Nec timuit sibi ne vitio quis verteret. Non ludo sed vitâ discimus. Non solum nobis sed aliis, et præcipue amicis nostris divites et potentes esse volumus. Domus ædificatur dominis non muribus. Philosophiæ, meo summo gaudio, semper vaco. Hic Marius veniet tibi origine parva. Numquid oratus es mihi propter hasce pessimas res. Quid amico gratius est quàm facies amici diu absentis iterum videre. Quidam homines in hac urbe non modo sunt inutiles nobis, sed etiam civitati nostræ admodum noxii. Ver nobis est anni tempus jucundissimum. Bellum est moribus et artibus et religioni perniciosum. Quis ager nostro domicilio est propinquum. Quædam vitia hominum quibusdam virtutibus finitima esse videntur.

Translate into Latin:—

Which of you is like the king? All poets are near akin to (*cognate*) orators. Macedonia is very near to Thessaly. The Roman commonwealth bore few men equal to Publius Scipio or Cæsar. The philosophy of the Stoics is not

conformable to reason. It behoves all men to learn to live suitably with nature. Modesty is suitable to youth, and authority is suitable to old age. The grove is not capable of being penetrated by any rays of the sun. These stories (*fabulæ*) which you are accustomed to tell me and my sister are very destructive to religion and morals. This place is very fit for an ambush. School is by far the most fit place for boys, for there they may learn something that will be profitable to them. The daughter is very like her mother, and very dear to her father. This letter is very welcome to me, for it comes (*quippe quæ veniat*) from a friend most dear to me and to all my family. Demosthenes was a man most well disposed to his country, most dear to his friends, and most unlike a traitor. The books of Xenophon are welcome to all lovers of true philosophy. I am concerned in what Cæsar is doing. He has not come to the state as a help, but as a disgrace. For whose advantage has this great crime been perpetrated? He was an object of hatred to all our people. The general was more acceptable to the enemies of his country than to his own fellow-citizens or fellow-soldiers (*commilitibus*). The philosopher above all others should try to live agreeably to the laws of his own philosophy. What is more unlike light than darkness?

Self-Examination Questions.

What do you mean by the dative of advantage and disadvantage? What is meant by the ethical dative? Give instances of each. What is the poetical dative? Give an example. What is the dative of purpose or the attributive dative? Give a list of adjectives which govern the dative case. Which of these govern an accusative with a preposition, and which a genitive case? and when? and why? How is mutual likeness expressed in Latin? Give an example.

XXXV.

GREECE (*continued*)—ATTICA TO B.C. 500.

LEAVING the Peloponnesus, we must now briefly review the history of Attica, whose capital was Athens, the most celebrated by far of all the Greek states. If the history and literature and art of Athens were omitted from the history, literature, and art of Greece, the latter would have had but small influence on the world, and perhaps it would hardly have been worth our reading. Attica was inhabited by Ionians, and in very early times consisted of a number of small states of which Athens was the strongest. Athens had always pursued a more liberal policy than Sparta. Instead of reducing its weaker neighbours to slavery, as Sparta did, it incorporated them, allowing them as far as possible to retain, or gradually restoring to them, their old political privileges, and admitting them to equality with its own citizens. Thus, when we come to historic times we find Attica forming one strong united people, whose nobles were not obliged to devote all their energies, like the Spartans, to keeping down a hostile population. A milder and juster spirit prevailed throughout Attica, and its constitution was based on more liberal principles, which gradually developed into a perfect democracy of the ancient type. We say of the *ancient* type because it is hardly consistent with our notions of a perfect democracy to allow slavery and the absolute exclusion of great numbers of the people from political power. But in the ancient democracies this was almost always the case.

Liberal policy of Athens.

In very early times we find Attica ruled over by a king who was also the chief priest. In time the nobles took away his priestly character and called him Archon or Ruler. Then they elected the Archon for ten years instead of for life; and at last, in B.C. 683, they cut down his term of office to a year, and instead of giving all the power to one man for that year, they distributed it among nine Archons. Thus Athens gradually passed from monarchy to oligarchy. The people were divided into three classes—nobles, farmers, and artisans. The nobles possessed all political power, and controlled everything connected with religion. The farmers and artisans had no share in the government at this time, nor did they obtain any share until Solon, about 600 B.C., gave them the right to vote in the public assembly.

Early forms of government in Attica.

But before we come to Solon, we must say something of Draco, the earliest Athenian legislator of whom we have reliable accounts. Before his time (B.C. 624) there were no written laws in Athens. The nobles alone were acquainted with the laws, and they handed them down by word of mouth from generation to generation. The common people complained that the nobles did not distribute equal justice to all—that they favoured their own class and friends. Great discontent was the consequence, and at last the nobles agreed that a code of written laws should be drawn up by one of themselves named Draco. He ascertained and wrote down the existing laws, but did not make new ones, so that he was not, strictly speaking, a legislator. In those primitive times punishments were usually very severe. Draco himself said, "The smallest crimes deserve death, and I know of no heavier punishment for greater ones;" so his code ordains death as the punishment for all crimes. To the Greeks in later times, when they were able to distinguish more nicely between the guilt of different crimes, these punishments of Draco seemed so severe that they said his laws were written in blood, not ink. But matters did not much improve in Athens after Draco's labours: discontent continued. One of the nobles, Kylon by name, attempted to make himself Tyrant, but was defeated and sacrilegiously murdered by one of the Alkmæonidæ, a powerful family of nobles, and the whole family had in consequence to go into exile some years after.

Draco, B.C. 624.

Solon was now (B.C. 597) the most influential and most trusted citizen of Athens. We know little of his early life. He was of noble birth, but poor, so that he became a trading merchant, and in this way visited many parts of Greece and Asia, and became acquainted with men and things which at that time there was no way of becoming acquainted with except by travelling. He was a poet as well as a traveller, and his reputation for wisdom in later times caused him to be considered one of "the seven wise men of Greece." In B.C. 594 the nobles chose him Archon, but gave him unusual and almost absolute powers to legislate in whatever way he thought best for the country. There was need of some saviour of society at that time in Attica. The poor had been for a long time getting poorer, and great numbers of them were actually reduced to slavery owing to their being obliged to borrow money from their richer countrymen at high rates of interest, so that they went on getting deeper and deeper into debt, and were obliged to pledge their farms and finally *themselves*, and when they were hopelessly involved they were adjudged slaves of their creditors, and were sometimes even sold to "barbarians." There was imminent danger of a social war of the people against the nobles. Happily the nobles were not all equally rapacious, or at least they had the good sense to see the evils the state was drifting into; and happily also there was one man in Athens in whose strength and justice poor as well as rich could put their trust. Solon set to work with no half measures. He saw that the poor debtors must be protected from slavery at any cost. He therefore immediately decreed that all existing contracts in which the land or person of a debtor had been pledged as security should be cancelled, and ordered all debtors who had been thus reduced to slavery to be set free, and forbade for the future all such contracts. Moreover, he redeemed from slavery as far as possible those Athenians who had been sold to foreign masters.

Solon, B.C. 597.

His reforms.

To help persons who were thus deprived of valuable slaves to pay off their own debts, he ordered a new coinage to be made in which the value of the new coins was only about three-fourths of the value of the old ones, and ordered that all debts should be paid off in the new coins. Thus a man who owed 100 of the old drachmæ (the common silver coin of the period) was enabled to pay it off with 73, because he could buy 100 new ones for 73 old ones; and Solon ordered the new to be accepted just as if they were the same value as the old.

These were undoubtedly very strong measures, and must have worked great injustice to many persons. At the present day we should consider them rank communism—a veritable confiscation of property. Nothing could have justified them in Attica at that time, except the extreme peril in which society was placed, owing to the accumulated evils of harsh laws and the necessity of saving society from bloodshed and anarchy by any means at hand. It is unfortunately too true that when society has got into such a desperately bad state it is almost impossible to save the innocent from suffering with the guilty. Solon himself seems to have felt the imperfections of his measures, for he is reported to have said that they were not the best he could devise, but the best that Athens could bear. Having now removed the greatest blot on the laws of his country, and dispelled all immediate danger of a social war, he proceeded to remodel the constitution and improve the laws. He gave to the assembly of the whole people the right to elect the Archons and to pass laws and to call state officials to account for what they had done while in office. He established a council of 400, whose duty was to prepare the laws that were to be submitted to the general assembly, and these councillors were also elected annually by the whole body of free-born natives. He next divided the whole free-born population of Attica into four classes, according to the amount of land they possessed. The higher the class the more political privileges he gave its members. For instance, none but persons of the highest class could be chosen Archons. Thus the chief power still remained in the hands of the wealthiest; but the rest of the people had very considerable control, and were enabled gradually to get more and more influence and to qualify themselves by experience for the more direct management of affairs which they subsequently acquired.

Changes in the constitution.

There is just outside Athens a small hill called Areopagus—*i.e.* the Hill of Mars. It is the same which is mentioned in Acts xvii. as the place where St. Paul addressed the Athenians, and it was known by the same name in Solon's time and even centuries before. It gave its name to an assembly or court of Athenian nobles, who for centuries before Solon's time used to meet here to try cases of murder. Solon enlarged the powers of the court of Areopagus, and gave it the right to forbid the passing of any law which it thought dangerous to the state, and also the power to censure citizens whose mode of life was unworthy of Athenians. It was not elected; but the Archons, after their year of office, became life members, so that it was a body of the highest and most experienced persons. It exercised great influence on public opinion, and retained that influence for many centuries, through all changes in the form of government. Solon also mitigated the harsh powers which the law gave to fathers over their children, and forbad for the future that a father should sell or kill his sons, as hitherto he might. One enactment of Solon's appears to be unique. He laid severe penalties on all persons who should stand neutral in civil troubles,—his object, no doubt, being to make every one take an active part in upholding right, and not to allow affairs of state to become a game carried on by party leaders while the mass of people looked on with indifference.

Areopagus.

Solon, like Lykurgus, having completed his reforms, in order to avoid constant changes decided to withdraw from Athens, but only for a time—about ten years. When he returned

he found Attica nearly as troubled as ever with rival factions. At last Pisistratus, an ambitious noble, succeeded in raising himself to the position of Tyrant. Solon protested energetically, but in vain, and the Tyrant was magnanimous enough to permit Solon to live and die unmolested in Athens. The reign of Pisistratus was mild and orderly. He beautified Athens, and encouraged literature and art, and made good roads, and gave Athens a splendid supply of water. He was succeeded by his two sons Hippias and Hipparchus, who at first followed the mild methods of their father; but Hipparchus having been assassinated by two young citizens named Harmodius and Aristogiton, in revenge for an insult offered by Hippias to the sister of one of them, Hippias became suspicious and cruel, until the Athenians could stand it no longer, and by the aid of the Spartans he was driven out.

Pisistratus.

MILTIADES.

of the Assembly, giving the right to vote in it to aliens settled in Attica, and dividing the council into committees for the greater despatch of business. He also instituted ten "strategi" or generals, one to be elected by each of the ten tribes, and each to command the army in turn for one day. By this means he hoped to prevent any one general from getting the army under his power. But the strangest of his institutions was that called "Ostrakism." Its object was to enable any dangerous citizen to be expelled for ten years by a simple vote by ballot of the people, without the uncertainty and excitement and delay of a trial. The council had to declare that the state was in danger. The people were then summoned to meet on a certain day, and each had to write on a ticket the name of the person he considered most dangerous to the state. If the same person's name was found on 6000 tickets that person was exiled

Ostrakism.

SOLON IN THE TREASURY OF CRŒSUS.

The old struggles between the rival nobles began again, until another ambitious, and fortunately for Athens a wise ruler, made himself Tyrant. This man was Kleisthenes. He carried on the work of Solon a step further, enlarging the power for ten years—a period which was supposed to be long enough to break down his dangerous power, so that at the expiration of that time he was allowed to return and resume his property and full rights.

Kleisthenes.

Such great democratic progress brought

down the anger of the Spartans and some of their allies on the Athenians, whose democratic principles the Spartans feared might penetrate among their own countrymen. But the aggression of the Spartans was triumphantly repelled by the Athenians, whose spirits and enthusiasm for the new order of things rose in proportion to their victories.

Sparta attempts to crush Athenian liberty.

V.

AUSTRIA.

AUSTRIA, or more correctly AUSTRIA-HUNGARY, is a dual monarchy consisting of the two states of Austria and Hungary united under one monarch, who bears the titles of emperor of Austria and king of Hungary. It comprises an extensive territory situated in the southern portion of Central Europe, between lat. 42° 10′ and 51° 3′ N., and longitude 9° 31′ and 26° 21′ E.; and bounded on the north by Saxony, Prussia, and Russian Poland, west by Russia and Roumania, south by Roumania, Servia, Bosnia and Herzegovina, Montenegro, the Adriatic Sea and Italy, and west by Switzerland and Bavaria. It lies compact, somewhat in the form of a trapezium, except a long narrow strip of land extending for several hundred miles in a south-east direction along the Adriatic and forming Dalmatia. Its greatest length from east to west is 810 miles, and its greatest breadth 667. It has an area of about 240,000 square miles, being third in point of size among the European states (after Russia, and Norway and Sweden), and in point of population also third (after Russia and the German empire) having in 1880 37,741,434. Hungary alone has an area of 124,400 square miles and a population of 15,610,729.

Austria is, after Switzerland, the most mountainous country of Europe. About three-fourths of its surface is mountainous or hilly. The Alps enter the country from Switzerland and spread themselves over the south-west portion of it. The scenery here is in some parts not surpassed even in Switzerland. There are lofty peaks with rugged, bare, and precipitous sides, snow-crowned summits, glaciers, cascades, avalanches. The loftiest summit is the Ortler Spitze (12,814 feet). In the north-west are the Hercynian mountains, under which name are included the several mountain ranges of Bohemia, Moravia, Silesia, and the northern portions of Upper and Lower Austria. The principal are the Böhmerwald or Bohemian Forest, the Erzgebirge, Riesengebirge, and the Sudetes. They are of considerable extent, but have no great elevations. The Carpathians rise near Pressburg on the Danube, and describe a great curve, bounding Hungary on the north-west, north, and north-east, and Transylvania on the east and south, and terminating at Orsova on the Lower Danube. They are about 800 miles in length, and occupy in the country about 72,000 square miles. Austria has also a number of extensive plains—as the Great and Little Hungarian plains, the Galician plain, and the Croatia-Slavonian plain. The mountains of Austria form part of the great watershed of Europe, so that some of its rivers flow northward into the North Sea or the Baltic, others southward or eastward into the Adriatic or the Black Sea. The principal river is the Danube, which flows from west to south-east, through the length of the country, and drains about 73·5 per cent. of its area into the Black Sea. Its principal affluents are—on the right, the Inn, Traun, Enns, Leitha, Raab, Drave, and Save; and on the left the March, Waag, Gran, Theiss, and Temes. The Elbe, which has the upper part of its course here, drains 9·3 per cent. of the area into the North Sea; the Vistula and Oder, whose head streams are here, drain 7 per cent. into the Baltic; the Dniester, which likewise rises here, drains 5·6 per cent. into the Black Sea; and the Adige drains 1·9 per cent. into the Adriatic. The lakes are numerous, but mostly of small size.

In the variety of its mineral products Austria is unsurpassed by any other European country. Except platinum, there are none of the useful metals but are found here, and many of them are in abundance, They comprise iron, copper, lead, tin, silver, gold, zinc, antimony, quicksilver, arsenic, cobalt, nickel, bismuth, chromium, uranium, tellurium. Besides these are coal, salt, sulphur, saltpetre, alum, petroleum, asphalt, etc. Austria also surpasses every other country in Europe in the number and variety of its mineral springs. Among the most celebrated are Karlsbad, Marienbad, Franzensbad, Bilin, Püllna, Teplitz, Sedlitz, and Gastein.

The climate varies greatly in different parts, owing to the great extent of the country, its continental position, and the differences in its elevation; but in general it is mild and salubrious. In the south the seasons are mild and agreeable, the winters being short, with little snow or ice, and the summers lasting for five months. In the central regions the seasons are more marked, the winters being longer and more severe, and the summers shorter and hotter. In the north the winters are long and cold. About one-third of the productive area of the country is occupied by forests, chiefly of oak, ash, elm, beech, pine, fir, larch, etc. Among the fruit-trees are apple, pear, cherry, plum, peach, apricot, fig, olive, almond, orange, lemon, pomegranate. The vine is extensively cultivated, particularly in Hungary and the south; so that this ranks as the third wine-producing country of Europe—after France and Italy. The principal agricultural crops are wheat, rye, oats, barley, maize, rice, millet, and buckwheat. Among the other productions are potatoes, beans, peas, turnips, beet, hemp, flax, tobacco, hops. In manufacturing industry Austria has made great progress within the last quarter of a century. Its manufactures include cotton, woollen, linen, and silk goods; gold, silver, iron, lead, copper, tin, and zinc

articles; leather, paper, tobacco, beer, brandy, sugar, glass, porcelain and earthenware, chemical stuffs, scientific and musical instruments.

Formerly the trade of Austria was very much hampered by high duties and restrictions of various kinds. Now these have been removed or very much modified, and in consequence the trade has greatly increased. The internal trade of the country is very considerable, and consists chiefly of the exchange of the products of one part of the country with another. The external or foreign trade is principally carried on overland, to the extent of about 82 per cent. of the whole. In 1879 the total imports amounted to £63,140,000, and the exports to £69,180,000. There are in the monarchy 4240 miles of river and canal navigation, 52,500 miles of roads, and in 1881 11,482 miles of railway. Owing to the great inequalities of the surface, some of the railways present engineering works of great skill.

The population is made up of many distinct races, differing from each other in manners, customs, language, religion. Upwards of twenty different languages and dialects are spoken. The two principal races are the Germans and Magyars or Hungarians, the former being dominant in Austria, the latter in Hungary, but in neither do they form a majority. The Germans constitute 25 per cent. and the Magyars 16 per cent. of the whole population. The various races of Slavs make up together 45 per cent., but they speak different languages and have otherwise little in common. Besides, they are mostly confined to the northern and southern parts of the country; so that they are separated from each other by a wide tract inhabited by Germans and Magyars. The Slavs in the north are the Czechs, Poles, and Ruthenians, in the south the Croats, Serbs, and Slovens. Among the other races are Roumanians, Italians, and Jews; the last number about 1,400,000. The Roman Catholic is the established religion, but other sects are tolerated. The chief of these are the Greek Catholic and the Oriental Greek Churches, Lutherans, Calvinists, Unitarians, and Jews. A system of national education is established, with elementary, middle, and high schools, as well as numerous special schools for particular branches. There are besides ten universities, of which that of Vienna is reckoned the first in Germany, having nearly 300 professors and teachers, and 4000 students.

The monarchy consists of two states, each having its own constitution and laws, but united for certain common purposes, and governed by one monarch, in whom the executive power is vested, and who shares the legislative power with the representative bodies of the two states. The Reichsrath or imperial parliament of Austria consists of two houses—one of lords, the other of deputies, the latter being composed of 353 members. The Hungarian Reichstag or National Diet consists of an upper and lower house, the former known as the House of Magnates, the latter as the House of Representatives. For matters common to the two states there is a controlling body called the Delegations, consisting of 60 members for each state chosen annually by the several Houses. The army on the peace footing numbers 17,621 officers and 267,814 men, capable of being raised during war to 32,286 and 1,086,933 respectively. The navy numbers in all 65 ships, of 124,200 tons, carrying 320 guns and manned by 9,895 men. According to the budget for 1881 the revenue for the monarchy was £11,584,591, expenditure £12,218,401; for Austria, revenue £40,964,599, expenditure £46,311,230; Hungary, revenue £26,441,471, expenditure £28,718,009. The public debt was for the monarchy £40,851,642, Austria £275,582,759, Hungary £100,133,035. The principal towns, with their populations in 1880, are—Vienna (1,103,857), Buda-Pesth (359,821), Prague (162,318), Trieste (144,437).

XIII.

VOLTAIC ELECTRICITY (*continued*).

LET us now return to our jar of acidulated water and metal plates—or, as we must now learn to call it, our "voltaic cell."

We see that when the two plates are unconnected no chemical action takes place, but that immediately they are united, either inside or outside of the liquid, the zinc is violently attacked. Let us see if we can, in the light of the principles we have just established, give some explanation of this phenomenon, and of the production of electricity by its means.

Explanation of changes in the cell.

For the sake of simplicity, we will first suppose the liquid in the cell to be pure water, neglecting for the present the sulphuric acid which it contains.

Water is, as our readers probably know, composed of two gases, oxygen and hydrogen, which having a certain strong liking, or, as we say, *chemical affinity* for each other, remain, so long as they are not too powerfully affected by external circumstances, firmly united together to form this well-known liquid. Now, just as with every other kind of matter, whether solid, liquid, or gaseous, the physicist believes water to be made up of a vast number of extremely minute particles which he calls "*molecules*," or little masses, each of these molecules being so extremely small, that by no mere physical process can it be subdivided, but nevertheless, small as it is, being to all intents and purposes water just as much as the largest body of that fluid which it is possible to imagine.

The molecular theory.

Here the physicist stops. This molecule, which he defines as "the smallest particle of a substance which can exist in a separate state," he takes as his unit which he employs in all his theories and calculations.

Definition of a molecule.

But where the physicist stops the chemist

comes in and takes up the tale. He takes the molecule of the physicist and by *chemical decomposition* splits it up into its component *atoms*, defining an atom as the "smallest possible particle of an elementary substance, and which is totally indivisible." This *atom* is the unit of the chemist, in the same way as the *molecule* is the unit of the physicist. If we have made ourselves perfectly clear, it will be understood by our readers that the molecule is the smallest particle of a substance, whether simple or compound, which can be obtained by mere physical division, when carried to the farthest extent which the imagination can conceive; while the atom is the smallest particle of a simple substance or *element* which can be obtained from the *chemical* decomposition of a molecule, each molecule, whether simple or compound, being composed of at least two atoms—if the former, of *similar* atoms, if the latter, of *dissimilar* atoms.

The atomic theory.

Employing, then, in this sense the words atom and molecule, we say that each molecule of water is made up of three atoms, two atoms of hydrogen and one atom of oxygen. This fact the chemist signifies by writing the symbol for water, in a kind of chemical shorthand, OH_2 or H_2O.

Now, when in our cell the zinc and copper plates are united, a disturbance of the chemical equilibrium of the water takes place. Strong as is the *affinity* of oxygen for hydrogen, it has a much greater liking for copper, and an affinity much stronger still for zinc. Consequently the molecules of water are decomposed—the oxygen uniting with the zinc to form *oxide of zinc*, and the hydrogen being given off at the copper plate.

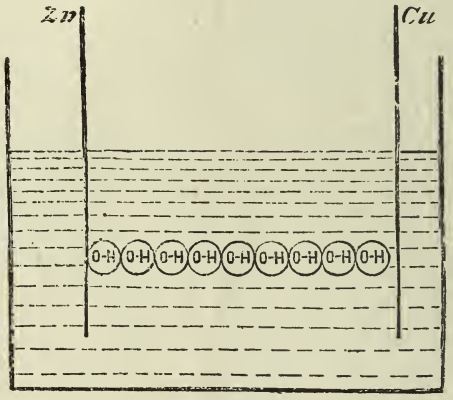


FIG 47.

We may represent this graphically, as in the annexed diagram, fig. 47.

Here we have an imaginary chain of molecules of water stretching from the zinc to the copper plate. It will of course be remembered that when the plates are put in the liquid, and *before they are connected by a wire*, they assume opposite electricities, the zinc plate *in the liquid* becoming positive, the copper becoming *in the liquid* negative. The ends out of the liquid, or the wires attached to those ends, will of course be respectively negative and positive.

The zinc plate, having a greater affinity for oxygen than the copper, attracts towards itself the oxygen end of the first molecule of water in our imaginary chain, thereby weakening its hold upon its hydrogen. This hydrogen attracts towards itself the oxygen end of the second molecule; and this series of changes passing through the whole chain, causes the last molecule to present its hydrogen end to the copper plate.

Chemical affinity.

This state of affairs remains so long as the plates are unconnected, but directly the connection is made the positive electricity at the end of the copper wire unites with the negative electricity at the end of the zinc wire, and an instantaneous electrical discharge takes place through the whole system or *circuit*. The oxygen of the first molecule of water in our chain is torn away from its hydrogen, and unites with the zinc to form oxide of zinc; while the released hydrogen unites with the oxygen of the second molecule, which is in its turn decomposed, and this decomposition and rearrangement passing along the whole line of molecules, the hydrogen of the last having no oxygen with which to unite, and having no affinity for copper, is there given off in the state of gas.

This discharge of course produces electrical equilibrium, but the same phenomena being continuously repeated result in that apparent flow of electricity which we denominate an electric current.

We are now in a position to understand that this current is due to the balance between two chemical forces. On the one hand the copper tends to attract the oxygen of the water, while on the other the zinc also attracts it, and its attraction being the more powerful is eventually successful. It is obviously the difference between these two opposing forces which constitutes the force which urges the current onwards, and to this difference it is usual to apply the name of the *electro-motive force*.

If our principle be true we can at once prophesy the result of employing two plates of the same metal instead of plates of different metals. Suppose, for instance, we take two plates of zinc. Here obviously the attractive forces will be equal, and the electro-motive force, *which is the difference between these attractive forces*, is of course *nil*—a result which is amply verified by experiment.

Application of theory.

From the same principle we may naturally be led to expect that the greater the difference between any two metals in their liability to be acted upon by the liquid employed, the greater will be the electro-motive force produced; and this is as a general rule found to be correct.

In our explanation of the production of an electric current in a cell we assumed the liquid employed to be water, although, as we have stated, dilute sulphuric acid is generally used

Electrical conductivity of water.

The reason for this is that the oxide of zinc formed does not readily dissolve in water, bu tends to cling to the zinc plate, and, being a bad conductor of electricity, to impede the action of the cell.

The explanation of the chemical action which takes place when sulphuric acid is employed is precisely similar to that just given for water, The molecule of sulphuric acid consists of one atom of sulphur, two atoms of hydrogen, and four atoms of oxygen—a fact which the chemist expresses in his symbolical notation as H_2SO_4. From this compound molecule the hydrogen is displaced, and the SO_4, or *sulphion* as it is usually called, unites with the zinc to form sulphate of zinc ($ZnSO_4$).

Negative and positive metals.

By a knowledge of the relative facilities with which the metals unite with oxygen, we may easily predict, not only the proportionate magnitude of the electro-motive force when they are employed as a galvanic couple, but also which of them will be positive and which negative. If, for instance, we employ a plate of gold and one of copper, the gold being much less oxidisable than the copper, will assume the negative, the copper the positive electrical condition, whereas with zinc copper is, as we have seen, negative.

Electro-motive series.

In the following list some of the principal elements are arranged in order such that any one is *electro-positive* to any other which is *below* it, and consequently any one *electro-negative* to any other which is *above* it. Such a series is called an *electro-motive series*; and it will be easily seen, from what has been stated above, that when any two of these metals are employed to form a voltaic couple, the current will flow in the connecting wire from the one lower in the list to the one higher.

+	Iron	Silver
Zinc	Nickel	Gold
Cadmium	Bismuth	Platinum
Tin	Antimony	Graphite.
Lead	Copper	—

XXXVIII.

SYNTAX (*continued*).

§ 235. *Pronouns.* (*a*) Personal, (*b*) possessive adjective, (*c*) relative, (*d*) indefinite.
§ 236. *Adjectives.* (*a*) Of class and quality, (*b*) use of articles *a* and *the*, (*c*) comparatives.
§ 237. *Verbs.* (*a*) Sequence of tenses, (*b*) infinitive, (*c*) sign of infinitive after auxiliaries, (*d*) gerundial infinitive, (*e*) participles, (*f*) verbal noun.

§ 235. **Pronouns.**—(*a*) *Personal* pronouns agree with the noun for which they stand in gender, number, and person: "*Mary!* are *you* going?" (2nd pers.); *John* has lost *his* book (3rd pers. sing., masc.). In the second person, the old objective case of the plural *you* has come to be used as a true nominative for the singular, in place of the old nom. sing. *ye:* it has, however, brought the concord of a plural verb along with it; we must say "you *are*," "you *eall*," not "you *art*," "you *callest*"; though addressing but one person, the plural form must agree with its nominative. (A similar change has taken place in German, where the 3rd person plural is used for the nominative of the 2nd personal pronoun in the singular—*Sie haben*, you have.)

The indeterminate sense of *it*, which often stands in apposition to masculine, feminine, and plural subjects, and acts as an indefinite object, is an exception to this rule. (See § 159 *b*.)

Much that has been said about nouns as subject and object applies also to pronouns. As pronouns, however, retain so much more inflexion, more care is required to use them correctly. *Note* that as the verb *to be* takes the nominative after as well as before it, such sentences as That's *me*, It is *him*, who is to go?—*Us* three, are wrong, though in familiar language some of these mistakes are often made. That is *I*, It is *he*, *We* three, are right. The pronouns are in these cases in apposition; a pronoun is sometimes put in apposition to a noun for the sake of emphasis, when they must of course agree: The rose, *it* is ruddy; "Thy banks, *they* are furnished with bees."

Pronouns following the comparative conjunction *than* are put in the nominative case, except the relative *who*, which takes the objective case :—

Than *whom* I could not wish a better friend.

No one quicker than *he* at climbing.

She is taller than *I* (am); not 'than *me*.'

He bears pain better than *we* or *they* do.

(*b*) The *Possessive adjective-pronoun* of the third person agrees with the gender and number of the possessor, not of the thing possessed (as in French and Latin): John has his book, Mary her knife, the child its rattle.

(*c*) The *Relative* agrees with its antecedent noun * (§ 162, *a*) in *number and person.* This is not shown by the inflexion of the relative itself in the majority of cases, but by the verb to which it is subject. In "the boy who *was* late," and "the boys who *were* wandering," the relative is the same in form; but each agreeing with its antecedent, it becomes the subject of the verb, which also agrees with the number and person of the antecedent. The *case* of the relative depends on the verb of the sentence which it introduces, and may be sometimes in the accusative—"They *whom* we love are noble," where *love* governs the accusative; or the dative—"She to *whom* I gave the book," where *gave* governs two objects, the dative being one; or the possessive—"Thou, *whose* glory fills the skies," where *glory* is subject to *fills*. The relative is in the nominative, if no noun come between it and the

* An adjective must not be the antecedent to a relative. "Homer is remarkably *concise*, which renders him agreeable," is wrong; this is a careless and common error.

verb: "Tell me *who* I am" (not *whom*, because the verb *to be* takes nominative before and after); The mother *whom* you weep for; Do you know *whom* you speak of? (here the accusative is governed by the verb and preposition). The relative accusative is often omitted: The mother you weep for, The house [*that*] I have built. Sometimes, too, the antecedent is omitted, as in [They] "Whom the gods love die young";

[He] "Who steals my purse steals trash."

Observe that the relative and interrogative precede, instead of following, the verb which governs them.

(*d*) The *Indefinite* pronouns—each, every, either, neither—are followed by a verb in the singular: "Every man *bears* his own burden"; "Each of us *is* to blame"; "Either *is* good, but neither *is* better still."

§ 236. **Adjectives** (*see* § 231).—(*a*) The noun may be suppressed after an adjective denoting (1) a class, or (2) an abstract quality, but the adjective must generally be preceded by the demonstrative *the*.

"Yes, let the *rich* deride, the *proud* disdain."
GOLDSMITH.

". . . the wounded steed
Tramples the *dying* and the *dead*."
WARTON, *Ode to Fancy*.

"Our ideas of the *Sublime* and *Beautiful*."
BURKE.

The *first* sort are treated as plural nominatives, the second as singular.

(*b*) The use of the demonstrative *the* and of the indefinite *a* (often called articles) are regulated by the need of distinctness. In the case of *a*, certainty as to number is produced by its repetition. "Bring me a hammer, chisel, bradawl, and nails," is not correct, because *a* signifies one thing, and several are demanded; the *a* should either be suppressed altogether, or repeated before each singular noun: "Bring me a hammer, a chisel, a bradawl, and nails." On the other hand, where several adjectives qualify one noun, one *a* is sufficient, unless much emphasis is desired: "*A* still, small, *voice*" (1 Kings xix. 12); *a* large, round, sweet *orange*. "A white and black cat" means one cat, "*a* white and *a* black *cat*" means two. With *the*, such use is ambiguous as to number, but definite as to kind. "*The* white and black cat" means a certain cat of those special colours; "I am buying *the* white and *the* black *cat*" implies that two cats, one white and one black, of those colours are concerned; but it would be better to say "the black and the white *cats*." But in examples such as "I saw the Doctor and Master of the College," in which both titles may belong to one man, it is necessary to insert *the* if they denote two: "I saw *the* Doctor and *the* Master," etc.

The used before a comparative adjective is the old instrumental or ablative case of *thæt*, and means *by so much*. It takes the place of an adverb. Ex.: "*The longer* you remain, *the worse* for you."

(*c*) Adjectives in the different degrees of comparison take the following after them:—

Positive ... Black *as* ink (adverb).
Comparative. Greater *than* love (conjunction)
Superlative.. Kindest *of* friends (preposition).

§ 237. **Verbs.**—The uses of the indicative mood to express positive assertions and questions, and of the subjunctive mood to express doubt or possibility dependent on something else, have been shown (*see* §§ 175, 199). Though the *inflected* subjunctive is going out of use, subjunctive sentences formed with the help of auxiliaries are much employed. (*a*) The *sequence of tenses* must be rightly kept—that is, the subjunctive verb in a dependent clause must follow the same time, past, present, or future, as the verb in the principal sentence: "He thinks | he may come"; "She would go | if she were near."

The conjunction introducing a subjunctive is often omitted, and the position of verb and subject reversed, especially in poetry: "Were I you I would not do it";

"O! wert thou in the cauld blast."
"Had I the wings of a bird."

(*b*) An old rule says: "the *second of two verbs* is put in the *infinitive* mood," as "I wish to go." This is true if you do not take participles into account, but remember that they express the notion of the verb. In "I am *going* a walk," *am going* must be taken as one verb (continuous present tense), which we see can govern an infinitive in "I am going *to be* busy." So in "He *has been seen* to weep."

(*c*) The eight auxiliary verbs *shall*, *will*, *may*, *can*, *do*, *dare*, *must*, *let*, take the infinitive after them without the preposition *to*: I can run, He must die. A few transitive verbs do the same (*see* § 177): "I *saw* them fight," "He *feels* her tremble," "*Bid* me discourse," "*Hear* me talk." *Need* and *go* are sometimes used with to and sometimes without it: "You need not try," "I need to be helped"; "I shall go fetch my son" (often "go and fetch"); "I am going to fetch him." These are matters of custom, which in Elizabethan English was still more unsettled, as is seen frequently in Shakespeare and the Bible. (See further as to auxiliaries, § 238.)

The simple infinitive, being as before shown the noun of the verb (§ 177), takes the place of either subject or object (nominative or dative) in a sentence: To fight is dangerous; I wish *to fight*.

"*To be* or *not to be*, that is the question."
Hamlet.

(*d*) The infinitive of the verb being a sort of noun, had in Old English also a dative case; the distinctive ending being lost, while it is also preceded by *to*, it is now known from the simple infinitive by its position and sense. The *dative* or *gerundial infinitive* is *used after nouns and adjectives*: His *desire to read* is great, That is *good to eat*—*i.e.*, desire *to* or *for reading*, good *for eating*. Thus it expresses a purpose, and is found after verbs followed by *to* (or *for to*), when it means *in order to*: He eats to live; I went to see him.

The subject of the *Imperative* mood is con-

sidered as a nominative suppressed: (Thou) be still, (You) be quiet.

(*e*) The *Participle* when equal to an adjective may be used as attribute or predicate; if we call it an adjective in the predicate we must also acknowledge its verbal power, as this predicate is really the tense or voice of the verb to which the participle belongs (see §§ 85, 178). In "She has a *dying* brother," dying is adjective or attribute; in "Her brother *is dying*," *is dying* together form the present continuous tense of the verb *to die*. The same is to be said of the passive and past participles.

(*f*) The *Verbal noun* in *ing* (explained before, § 178) must be kept distinct from the participle in *ing;* the gerundial infinitive is readily convertible into a verbal noun in an objective case (after the preposition to or for), as above seen (*d*). The verbal noun takes the place of subject and object, and can be used with the possessive case.

Nom. with possessive. { The breaking of that window cost me much. [see.
{ The girl's rejoicing was good to

Objective. { Do that ironing at once.
{ Make your reckoning now.

BOTANY.

XXXIX.

VARIOUS ORDERS (*continued.*)

The Berberidaceæ.

THOUGH the berberics cannot be said to constitute a large and important family, they acquire great interest from the presence of the curious character, which we noticed in the close of our last article,—namely, valvular dehiscence of the anthers. In all other respects, except that both orders are exogenous, they differ widely, the berberies presenting also the contrast of many herbaceous species. The order, in truth, is one of very heterogeneous appearance, for nothing can be more unlike than an epimedium and a mahonia. Oddly enough, with the anther-character is always associated a certain amount of thorn or prickle-bearing; for although the epimediums have no weapons upon their stems and branches, the edges of the leaves are set round with thorns in miniature. The conspicuous and familiar plants of this order are the shrubby ones represented in the common wild English berbery. Of late years many beautiful species of the same genus have been introduced from the cooler parts of India, from north-west America, and the extreme south-west of South America. These are now inmates of every good garden and shrubbery, being invaluable in the profusion of their golden bloom, which comes ordinarily very early in the season, and is generally all over long before midsummer. In autumn they are again beautiful with their red or purple fruit, and the mahonias, all the year round, are a delight in their rich and glossy foliage. Berberies, strictly so called, have simple and undivided leaves; those of the mahonias are pinnate. In any case the flowers are yellow, hexamerous (a rare circumstance in exogens), the sepals and petals soon falling away, all being quite free, and very lightly attached, and provided with six stamens. Over and above the rare peculiarity of the anthers just now mentioned, the stamens of the berberies, and very notably those of the commonest species, possess that other attribute, so strange and wonderful, which in books is usually termed irritability. When fully developed, a berbery flower is a little golden cup formed of six free and concave petals, in front of every one of which there is a stamen, that seems to lean, as if tired, against the petal. Touch it ever so lightly, at the base, with the point of a pin, and it immediately springs up, reminding one of the similar conduct of the leaflets of the sensitive plant, and of the pistil of the stylidium. After a while, the stamens resume their recumbent position, from which they may be again aroused by a gentle touch, again springing up, and returning at their leisure. The cause of this curious phenomenon is not yet clear. Sundry explanations have been offered, but there is no real solution. The herbaceous Berberidaceæ are exceedingly pretty plants, gems even in the choicest gardens, and quite as interesting in regard to the minute structure of the flowers as the shrubby and ligneous species. There is no instance in this family of anything deleterious. The berries of the berberies are in several instances, though acid, available for preserving. Other species are valuable in game-covers. Observe, in writing the name, that it is not formed from "berry," like gooseberry and strawberry, being simply an abbreviation of the Latin *berberis*, which is said, in turn, to be of oriental origin, though not denoting one of these varied plants in its primary use.

The Aurantiaceæ.

Families, as we have seen, are variously recommended. Sometimes we are astonished by their extent; sometimes by the splendour of the individual development. Here and there they furnish useful food, or medicines, or poisons. In the Aurantiaceæ, as in the plum and apple families, the excellent character of the *fruit-bearer* becomes conspicuous. For although many of the species yield nothing worth human eating, it is from the incomparable little group now before us that we receive the orange, the lemon, the lime, the citron, and the shaddock or "forbidden-fruit."

All the species are ligneous, and, in the main, of the stature and figure of the apple-tree. They are mostly evergreen, and the foliage being glossy, the complexion is in general highly pleasing. Normally, the leaves are slightly compound; but in the typical genus, Citrus itself, it happens very singularly, that the lateral leaflets are never developed, so that the remaining or terminal one looks exactly like an ordinary simple and undivided leaf. The true character is at once disclosed by the articulation of the lamina to the petiole,

which last is often very much dilated, and on the instant suggests something unusual. By this one simple mark it is easy, in most cases, to tell a Citrus from other similar evergreens. In addition, there is the grand feature, running throughout the order, of translucent oil-glands in the leaves, so that when looked at against the light they appear to be full of minute needle-pricks. The flowers are regular, usually tetramerous, with many stamens, the filaments of which are inclined to coherc at the base. The ovary is superior, with a solitary style, and usually a somewhat knobbed stigma. The delicate cream-white colour of the petals in the orange and lemon, and the delightful odour the flowers exhale, is well known. Unfortunately the petals, being free, are apt to drop off sooner than we can reconcile ourselves to their departure; but in despite of this the flowers still count with the loveliest, as the fruit does with the most delicious of nature's productions. It is in the last-named part that we have one of the most striking characteristics of the Aurantiaceæ as a whole, no other plants producing a multi-carpellary fruit, with separable carpels, and the carpels themselves crammed with bags of juice. The seeds, it is hardly necessary to say, seem attached to a kind of axis up the centre, though in reality contained within the carpels. The abnormal genus *Skimmia* presents a very considerable difference. The simple leaves are translucently dotted, and the small white flowers correspond pretty fairly, but the fruit, instead of being orange-like, is a little red berry, with a solitary hard stone inside. The principal home of these beautiful trees is India, in the forests of which favoured land the orange and several other species may still be seen wild. There is a good deal of doubt, however, as to the exact history of the orange as we know it in cultivation. Probably, like wheat, the grape, the apple, and the peach, it owes a good deal of its present royal quality to the care and attention of man, exercised during many ages. Oranges and lemons are too tender to endure the open air of our own country, though they thrive delightfully under the shelter of glass. The little skimmia, on the other hand, from Japan, is one of the most valuable shrubs we possess for out-door winter ornament, being evergreen, proof against cold, and covered with bunches of red berries. Although now so plentiful and cheap, oranges and lemons were not known in Europe till the ninth century. The citron was an earlier acquaintance, and possibly not unknown to the ancient Hebrews. The shaddock is of very recent date, the family name of the original introducer, Captain Shattock (*tt*, not *dd*), being still to be seen in the pretty little village of Bishops Lydiard, near Taunton. In addition to the incomparable dessert fruits bestowed so generously by this beautiful order, there are two or three of great value to the physician, foremost among these being the Indian Baël, or *Ægle Marmelos*. Lime-juice, indispensable on board ship, especially when the voyage is towards the home of the polar bear, is supplied by the *Citrus Limetta*. A word or two may be allowed upon the use of orange-blossom for bridal chaplets. Botany, in its most inviting idea, is something more than the anatomy of plants, the movements of their juices, and the ticketing them with Latin nomenclature. One likes to follow the plant through all the history of its life, its uses, and applications, and to inquire for its poetry as well as its physiology. Something is then got that is like the warmth of the sunbeam, over and above the glory of the light. The orange tree is evergreen,—this means faithfulness, constancy, and consistency. The flowers are white, the colour of purity and innocence. They are fragrant, giving a picture therein of the aroma of a kindly and loving character; and in the last place the fruit is in its way all that man can desire. In the last place? Nay. The orange tree is remarkable in having flowers, incipient fruit, green fruit, and fully ripe fruit, on one part or another, all the year round, or very nearly so. This, to the eye that is quick to recognise resemblances, renders it an image of the happy matron, circled by her grown-up daughters and her little ones, while the cradle itself has its tiny inhabitant. No herbaceous plants occur among the Aurantiaceæ. No species is deleterious, and none are indigenous to Europe.

FIG. 201.—LOCUST TREE.

The Rutaceæ.

In the strictly botanical sense, there is a very close degree of relationship between the Aurantiaceæ and the beautiful and very curious order which takes its name from the common rue, *Ruta graveolens*. The only absolute distinction, technically, consists in the structure of the fruit, that of the Rutaceæ being uniformly dry, and having a pericarp that separates into distinct layers or shells. But the complexion of the two orders is widely different. Trees, small ones, occur among the Rutaceæ, no doubt; but the majority of the species acquire the dimensions only of shrubs, and there are examples even of her-

baccous plants. Compound leaves are met with, but simple ones are the rule. In either case they are plentifully charged, as in the Aurantiaceæ, with oil cysts, thus presenting a similar dotted appearance when held between the eye and the light. The scent of the oil is quite the reverse of that found in the former order, where all is pleasant and invigorating, whether in flower or fruit. Recall the smell of common rue, and a good idea is at once obtained of the smell of the Rutaceæ in general, though in many cases, no doubt, it borders closely upon the properly aromatic. Many of the species, however, are devoid of scent, or nearly so. The flowers are either tetramerous or pentamerous, of all known colours except blue, put forth in very various ways, and although seldom large, often very attractive in their abundance. Greenhouses, when ruled by good taste, always have plenty to show, especially in spring and early summer, in the way of lovely Boronias, Correas, Eriostemons, Diosmas, and the like —plants for the reasons given invaluable. It is only under glass that they can be cultivated, the mass of the order being sub-tropical, or as represented in the warmer parts of Australia and at the Cape of Good Hope. The common or medicinal rue is a singular-looking undershrub, with doubly pinnatifid and very glaucous leaves, and umbellate clusters of yellow flowers, the petals of which are much wrinkled. Being European, it is perfectly hardy in our own island. In gardens, where these are not sacrificed to the deities of the floricultural branch of tattooing commonly called "bedding-out," may also be found that very beautiful and interesting rutaceous plant, the fraxinella, the only member of the order with irregular flowers. The bloom is produced in handsome erect clusters, and diffuses a rich and powerful odour. A family abounding in secreted oils can hardly fail to be useful to the physician. Hence, among the Cape species, we find those which supply the celebrated Bucku-leaves.

FIG. 202.—LIME TREE.

In the Sapindaceæ we have one of the orders which help to decorate the world with noble and beautiful trees, not forgetting at times that it is always an honour to a tree to yield good fruit or some other useful article. Like many other orders, it presents a considerable diversity of features; in one section so marked that many botanists prefer to regard this latter as a distinct and separate order, giving it the name of *Aceraceæ*.

The Sapindaceæ.

With the solitary exception of the horse-chestnut, the aceraceous trees are the only representatives of the family ever seen in England, in the open air; it will be best accordingly to speak of these before dealing with the Sapindaceæ in the limited sense. *Acer*, the ancient Roman name, designates the beautiful genus so well illustrated in the common sycamore and the common maple, not to mention the crowd of more dainty species of maple which occur in arboreta and well-furnished pleasure-grounds. The sycamore is distinguished at once by its large vine-like leaves, always *opposite* or borne two-and-two; the plane-tree, with which it is sometimes confounded, though of quite a different family, having them *alternate*. The large pink leaf-buds burst their envelopes very early in the season, giving one of the first signs of approaching summer. When they happen to have been quietly and inconspicuously progressing during a few dull and cloudy days, and then there comes a warm, bright, and exhilarating forenoon, they seem to start into green life all of a sudden, and the impression of rejuvenescence is most delightful. The suddenness is attributable, in part, to the leaves being folded up while young after the manner of a lady's fan when closed, and like the fan, they can be almost instantly expanded. The pendulous green clusters of honeyed bloom are full of emulation of the foliage. They are best seen by going underneath the tree, and looking up, as into a canopy, when the spectacle is something marvellous. In autumn the flowers are succeeded by very singular fruits, "samaras," that give the idea of some quaint exotic insect with wide-spread wings. There are never so many fruits in a cluster as there were flowers, many of the latter being destitute of a perfect pistil. Amends are made, however, for the curious, by the wonderful beauty of the inside of each little fruit. For in this, doubled up, biding their time, will be found the two seed-leaves of the future tree, bright green, and nestling in wool. A prettier and more interesting example of the rudimentary tree we have never met with in nature. The sycamore, though now so common as to seem a native, is not really indigenous. It was introduced from central Europe towards the time of Queen Elizabeth, and taking kindly to the soil and climate, seems to have at once set to work to naturalize itself. The common maple, Acer campestre, is, on the

other hand, an indubitable ancient Briton, and one of the trees we may be proud of, though in dimensions not equal to many others. The leaves are very much smaller than those of the sycamore, and the extremities of the lobes, instead of being acutely angular, are obtusely so. The flowers are in little umbellate clusters, and the wings of the coupled samaras are horizontal instead of converging. We have not space to do more than mention that at least a dozen other very ornamental species of the Aceraceæ are commonly cultivated, none surpassing, in variegated loveliness, the North American Negundo.

The Sapindaceæ proper are represented familiarly, as above said, only by the horse-chestnut—that illustrious tree which, when in full bloom, seems decked with a thousand lamps in celebration of some royal festival. The red-flowered horse-chestnut, and several species of Pavia nearly allied, are also tolerably common, though not, like their majestic leader, universal. The horse-chestnut must be carefully distinguished from the sweet or Spanish chestnut. The latter differs in every particular, belonging to a totally distinct family; and the names signify no more than that the *seeds* of the sapindaceous tree bear some degree of superficial resemblance to the *fruits* (pericarp and seed together), of the corylaceous one. The latter, Castanea vulgaris, we shall come to by-and-by. The horse-chestnut is a native of the mountainous country north of Turkey or thereabouts. It arrived in this country, by way of Constantinople and Vienna, first about the time of the defeat of the Armada, and, like the sycamore, at once claimed the citizenship to which it has ever since done so much credit. In tropical countries the Sapindaceæ are very often handsome, but not one of them perhaps excels the horse-chestnut in noble characters, though some might be considered more useful because of their products. That curious fruit, looking like a large dried brown raspberry, now common in the shops, and called the lychee or li-tchi, is the produce of one of the Chinese species. A few kinds are cultivated in hot-houses for the sake of their beautiful foliage, these including one or two kinds of Paullinia, plants that differ from the trees in being climbers of extraordinary power, and that ramble to a distance, in their native forests, almost incredible. The horse-chestnut and the Pavia are the only trees able to endure the open air in this country, which have *digitate* leaves. By this one simple mark they may always be infallibly determined.

Sapindus the typical genus of this family, is so named from the Latin *sapo*, soap; the husks of the fruit of the common Sapindus saponaria, when rubbed in water, giving rise to a dense lather. A sackful of them was sent to the great Hyde Park Exhibition of 1851. Another very curious production of this family is the so-called snake-nut, Ophiocaryon paradoxum, the embryo of which, large and loose, is coiled up in just such a way as to give the image of a tiny serpent. The tree producing it is a native of Guinea, the home of so many other curiosities, both vegetable and animal.

XXXII.

Possessive Pronouns and Adjectives.

II. The Possessive Pronoun.—This word is employed instead of a substantive previously mentioned, combining with it the idea of possession. In consequence of this reference to a preceding word—to an antecedent—it is strictly called *the possessive relative pronoun.*

Accepting the usual definition of a pronoun, this one claims the position from a double point of view: if after speaking of a book and of John, we say *his is best,* his stands for both book and John.

In French the possessive pronoun agrees with the antecedent (that is, *the thing possessed*) in gender and number, and there are thus four forms corresponding with every one of the three persons in speech, both singular and plural; therefore twenty-four forms in all.

Possessor.		*Ant. Sing.*	*Ant. Plur.*
1st P., S.	mine	le mien, *m.* la mienne, *f.*	les miens, *m.* les miennes, *f.*
2nd P., S.	thine	le tien, *m.* la tienne, *f.*	les tiens, *m.* les tiennes, *f.*
3rd P., S.	his hers its one's	le sien, *m.* la sienne, *f.*	les siens, *m.* les siennes, *f.*
1st P., P.	ours	le nôtre, *m.* la nôtre, *f.*	les nôtres, *m.* and *f.*
2nd P., P.	yours	le vôtre, *m.* la vôtre, *f.*	les vôtres, *m.* and *f.*
3rd P., P.	theirs	le leur, *m.* la leur, *f.*	les leurs, *m.* and *f.*

Examples.—Chacun de nous a son devoir à remplir: faites *le vôtre,* je remplirai *le mien,* each of us has his duty to fulfil: do yours, I shall perform mine. *Le vôtre* and *le mien* assume the shape required by the 2nd person plural and the 1st person singular, which are the possessors, and the gender and number of the antecedent *devoir,* noun possessed.

Observe that in French the possessive pronoun is not influenced by the *gender* of the possessor—as in English, where *his* stands for a masculine, *hers* for a feminine, and *its* for a neuter, possessor. The agreement takes place with the possessed: You will find my watch on the hook, and his below = *vous trouverez ma montre au crochet et* la sienne *dessous;* This napkin-ring is heavier than hers = ce rond de serviette est plus lourd que *le sien.*

The possessive pronoun is often used absolutely to denote possession, family, partisans, clients, soldiers, etc.

Je suis père de famille, je dois chercher à ménager LE MIEN, *I am the father of a family, I must try to husband* my means.

Il voudrait profiter de l'affaire sans y avoir mis DU SIEN, *he would like to derive profit from the concern without having put any money into it.*

Jamais on ne jouit si doucement de sa gloire que

parmi LES SIENS (Delille), *never does one enjoy so much one's glory as among* one's family.

Vous avez mis DU VÔTRE dans cette histoire, *you have put some of* your own (*invention, imagination*) *into that story.*

M. Lalande sera DES NÔTRES, *Mr. L. will join* our party.

The feminine plural form is likewise used absolutely in connection with *faire*, to designate pranks, follies.

je fais des miennes, *I play pranks;*
tu faisais des tiennes, *thou wast playing pranks;*
il fit des siennes, *he played pranks;*
elle fera des siennes, *she will play pranks;*
nous ferions des nôtres, *we should play pranks;*
faites des vôtres, *play pranks;*
ils ont fait des leurs, *they have played pranks;*
elles avaient fait des leurs, *they had played pranks.*

Remark.—These pronouns ought not to be taken to signify a written note or letter, when the antecedent *lettre* has not been mentioned. If in commercial correspondence it be admissible to say, *e.g., au reçu de* la vôtre *du 7 courant*, or *en réponse à* la mienne—such practice should not be introduced into social epistolary intercourse.

III. THE POSSESSIVE ADJECTIVE.—From the possessive pronoun arises the possessive adjective, which qualifies the noun before which it is placed by an idea of ownership, indicating at the same time that the possessor is of the 1st, 2nd, or 3rd person, singular or plural. This double property has led to the adoption of the designation *possessive adjective pronoun*, or *pronominal possessive adjective.*

It agrees in gender and number with the noun which it qualifies, the forms being for each person :

	Masc. Sing.	*Fem. Sing.*	*Plur. M. & F.*
my	mon	ma	mes
thy	ton	ta	tes
his, her, its, one's	son	sa	ses
our	notre	notre	nos
your	votre	votre	vos
their	leur	leur	leurs

Examples.—Certains auteurs, parlant de *leurs* ouvrages, disent: *mon* livre, *mon* commentaire, *mon* histoire; ils sentent *leurs* bourgeois qui ont pignon sur rue (Pascal). *some authors in speaking of their works say:* my *book*, my *commentary*, my *history; they remind one of purse-proud commoners* (middle-class men who have a gable—a house—in the street).—*Mon* gendre, *ma* fille, et *mes* petits-enfants sont à la campagne, *my son-in-law, daughter, and grandchildren are in the country.*

Observe that the use of *son* and *sa* does not depend on the sex of the owner, but on the gender of the noun possessed; thus one says : *le garçon apprend* sa *leçon*, because *leçon* is feminine; and *la fille apprend* son *catéchisme*, because *catéchisme* is masculine.

It happens, as in English, that these adjectives do not always denote strict ownership, but indicate some connection of habit, or of previous mention: *Mais ouais! il y a longtemps que l'heure est passée, et je ne vois point venir mon homme* (Brueys), but hullo! the hour has been past a long time, and I do not see my man come; *Il y tombe* (that is *le chat tombe dans le piège*) en danger *de mourir; et* mon *chat de crier* (La Fontaine), she falls into it in great peril of life, and my cat begins to howl.

Remark I.—For the sake of euphony *mon, ton, son*, are substituted for *ma, ta, sa*, before a feminine noun or adjective beginning with a vowel or *h* mute:

Prenons parti, *mon* âme, en de telles disgrâces (Corneille), *let us be resolved, O my soul, amid such misfortunes.*

Mon Hermione encor le tient-il asservi? (Racine), *does my Hermione still hold him enslaved?*

J'appréeie *son* aimable attention; j'envie *ton* heureuse audace, etc.

In the French anterior to the fourteenth century, *ma, ta, sa*, instead of being replaced by the masculine forms, were elided as the article now is; people said *m'esperance, t'ame, s'espée.* Of that practice there still remain in use the vestiges *m'amie* (travestied sometimes into *ma mie*), my dear, and *m'amour*, my love (which has the plural *m'amours*, endearments, fawning, etc.).

Remark II.—This pronominal adjective is repeated before each noun in a series when the first requires it:

Son enfance, sa voix, sa misère, et ses charmes à sa mère en fureur arrachent mille larmes (Voltaire), *his youth, voice, wretchedness, draw a thousand tears from his raving mother.*

The possessive adjective is also repeated before each of two adjectives, when both cannot be applicable to the same object or set of objects: Je lui ai montré *mes* beaux et *mes* vilains habits, *I showed him my handsome and my plain clothes*, the same set of clothes not being able to be at the same time handsome and plain. But say Tu m'as montré *tes* beaux et brillants équipages, because the same set of equipages may be both beautiful and brilliant.

Remark III.—In speaking to our relatives, we prefix *mon, ma, mes: Mon papa, dites-moi, s'il vous plaît; Mes enfants, venez ici*, etc. The omission of the possessive here points to a poetical form; carried into familiar conversation it has either an affected or a foreign ring.

Remark IV.—Politeness requires that when speaking to other people of their relations we should prefix *monsieur* (pl. *messieurs*), *madame* (pl. *mesdames*), *mademoiselle* (pl. *mesdemoiselles*), before the name indicating the degree of relationship:

Je vous respecte trop, vous et messieurs vos parents, pour être amoureux de vous (Molière), *I respect you and your parents too much to be in love with you.*—C'est ce que je voulais dire, madame votre tante. Comment se porte-t-elle? (do.), *just so, your aunt. How is she?*

To use these in speaking of one's own relations would be ridiculous and offensive: "Le prince de Condé voulant se railler d'une personne qui, pour se donner des airs de qualité, disait monsieur mon père, madame ma mère, dit en sa présence: 'Monsieur mon écuyer, allez dire à monsieur mon cocher qu'il mette messieurs mes chevaux à monsieur mon carrosse.'"

Remark V.—Mon, ma, mes, ton, etc., placed before adjectives and adverbs in the comparative of superiority and inferiority, form the superlative relative (*see* p. 765, vol. I.).

XXXVIII.

Ultra-Neptunian Planets.

Is Neptune the outermost planet of the solar system? That is a question which has at different times excited a considerable deal of speculation in the minds of astronomers. It will be remembered that Neptune was discovered from the perturbations which its attraction caused in the motion of its neighbour Uranus. Hence arises the question—Does Neptune exhibit similar irregularities in its motion? As far as we know at present the answer must be—No. But then the answer is not conclusive, for Neptune has not been properly observed for a sufficiently long time to enable us to feel sure. Two hundred years hence it will be possible, by the investigation of the actual motion of Neptune and Uranus, to say definitely whether or no there does exist an ultra-Neptunian planet capable of giving rise to perturbations in the motion of the planets interior to it. And unless the planet be very distant, quite exceptional in its distance, or considerably smaller than the other giant planets, it must give rise to perturbations in the motion of both Uranus and Neptune. But at present the consideration of the motion of Neptune fails to afford us any answer to our question—Do there exist ultra-Neptunian planets? So there arises the inquiry—Is there any other way in which an answer can be obtained? The reply is—Yes.

FIG. 94.—ENCKE'S COMET, NOV. 12, 1872.

It has been found that a large proportion of the known periodical comets are divided into groups in such a manner that in each group, when the comet is at its greatest distance from the sun, or is in aphelion, it lies quite close to the orbit of one of the giant planets. Thus the comets of short period have orbits which are so placed with regard to the orbit of the giant planet Jupiter, and this relationship is so marked that it has led astronomers to suppose that these comets may have been introduced into the solar system by the attraction of this planet. Many of the remaining periodical comets have orbits similarly grouped about those of Uranus and Neptune, as if they had been similarly introduced by those planets. If, then, this view of the mode in which periodical comets are introduced into the solar system be sound, it would be possible to detect other giant planets beyond Neptune by seeing if there exist similar groups of periodical comets.

Considering the periodical comets of long period, many would seem to divide themselves into three groups with aphelion distances of about 45, 75, and 100 times the mean distance of the earth, which on the assumption made would indicate the existence of three ultra-Neptunian planets, with mean distances of about 45, 75, and 100 times that of the earth, and periods of about 300, 650, and 1000 years; and it may be remarked that these distances correspond tolerably well with what from *à priori* reasons might be supposed to be the probable distances of these bodies.

If such planets really exist, how far is it likely that we should be able to detect them? As they would probably be of about the same dimensions as Uranus and Neptune, they would shine like stars of the tenth, twelfth, and fourteenth standard magnitude respectively, and their daily heavenly motions would be about 12″, 5″, and 3″ respectively. It is not improbable, sooner or later, if it exists, that the first might be picked up by some astronomer searching for minor planets, or by a comparison of different observations made with the view of mapping the heavens. But the detection of the others would not be possible in this manner, for they are too faint. If they were detected it would only be as the result of a prolonged systematic search with one of the most powerful telescopes. And such a search would be useless unless the actual place of the planet was known with some certainty. At present such a search would be hopeless.

Such planets may exist; and the further progress of astronomy may bring us data by which to determine the probable place of these hypothetical planets, and then a search may lead to the addition of other planets to the solar system. Time will prove.

Comets.

These mysterious bodies, which from time to time sweep rapidly across the heavens, may be divided into two great classes—namely, the periodical comets, which are true members of the solar system, and regularly return at the end of each revolution; and the non-periodical comets, bodies which arriving from distant space sweep round the sun in a parabolic or hyperbolic orbit, and depart again into space

to return no more. The former are of course the more interesting to us as being regular members of our system, though from time to time they may be momentarily eclipsed by some exceptionally brilliant or startling visitor from distant realms.

The periodical comets may be divided into three classes—namely, comets of short period, comets of moderate period, and comets of long period; and of these the first are perhaps the most interesting, as their more frequent returns enable us to better study their character and investigate their orbits.

The principal members of the family of comets of short period are the following:—

1. *Encke's Comet.*—Period 3·300 years; least distance from sun = 0·342; greatest distance from sun = 4·10; last return to perihelion, November 18, 1881; next return, April 1884. This is perhaps the most celebrated of these comets, and has been the one most frequently observed, having been seen on no less than twenty-one of its returns to perihelion, whilst it is the one whose orbit has been most carefully investigated. It had been discovered by Mechain in 1786, by Caroline Herschel in 1795, by Thulis in 1805, and by Pons in 1818, before its real periodical character was discovered. Encke, from the observations made in 1818-19, found that its orbit was unquestionably an ellipse of about 3¼ years period, and by examining a catalogue of the known comets was able to identify it with those seen in 1786, 1795, and 1805. He was consequently enabled to calculate its orbit with exceptional accuracy, and predicted the return of the comet in 1822. The prediction was completely verified, and since then the comet has been seen at all its returns. By a comparison of the time of its theoretical and observed perihelion passage, Encke was led to believe that the comet came back about 2½ hours sooner than it should according to theory, and that this acceleration was on account of its motion being hindered by some resisting or ethereal medium in space, this resistance tending to diminish the dimensions of the orbit of the comet, and so hasten its return to perihelion. At present nothing certain is known on this point, for it is by no means certain that this quickening of the apparent motion of the comet may not be due to some planetary perturbation not properly taken into account. No other comet seems to show the same acceleration unless it be Winnecke's comet, in which a similar but much smaller acceleration has been suspected by Oppolzer. Its amount may be gathered from the statement that whereas the observation of the years 1819 and 1822 seem to indicate a period of 1211·7 days, those at the present time seem to indicate a period of only 1210·0 days. But even if this acceleration be made out, it may not unlikely be due to the near approach of the comet to the sun and its retardation by the outlying portion of the solar atmosphere, or rather the atmospheric envelope to the great meteor streams which seem to surround the sun, and have been suspected to be the real origin of the phenomenon known as the zodiacal light.

FIG. 95.—DONATI'S COMET, 1858.

It may be mentioned here that comets are distinguished by the year of their perihelion passage, and the order in which they pass their perihelion: thus comet 1881 (ii) means the second comet which passed through its perihelion in the year 1881.

2. *Winnecke's Comet.*—Period 5·55 years; least distance from sun = 0·78; greatest distance = 5·50; last return, Dec. 1880; next return, April, 1886. Discovered by Pons, in June, 1819, but not again seen until rediscovered by Winnecke in 1858. Generally small and faint.

3. *Brorsen's Comet.*—Period 5·56 years; least distance from sun = 0·62; greatest distance = 5·66; last return, March 30, 1879; next return, Oct. 1885. Generally small and faint.

4. *Temple's Comet.*—Period 5·96 years; least distance from sun = 1·77; greatest distance = 4·81; last return, May 7, 1879; next return, April, 1885. Very faint, resembling in appearance a small rounded nebula. Approaches very close to Jupiter in 1882, when the attraction of that planet may materially alter its orbit.

5. *D'Arrest's Comet.*—Period 6·39 years; least distance from sun = 1·17; greatest distance = 5·72; last return, May 10, 1877; next return, Oct. 1883. Discovered by D'Arrest June 27, 1851. Its motion is subject to great perturba-

tions from the attraction of Jupiter. It is small and faint.

6. *Biela's Comet.*—Period 6·62 years; least distance from sun = 1·86; greatest distance = 6·19: last return, Sept. 23, 1852; next return quite uncertain,—should be Oct. 1885.

This comet was observed in 1772 by Montaigne, and in 1805 by Pons, but it was not until after its discovery in 1826 by Biela that its periodical character was detected. In 1832 and 1846 it was again observed, though found to be faint, and during its return it was seen to gradually separate into two portions which swept along in orbits close to one another. At its return in 1852 the two portions were still distinct, and had separated somewhat further apart. Since that time, though carefully searched for, it has never been found. On Nov. 27th, 1872, the earth swept across the orbit of this comet, and a remarkable display of meteors was observed, but no comet. Similarly it could not be detected in 1879. It seems to have vanished: perhaps become so expanded as to be too faint to be seen.

7. *Faye's Comet.*—Period 7·413 years; least distance from sun = 1·69; greatest distance = 5·92; last return, Dec. 29, 1880; next return, May, 1888. Discovered by Faye on Nov. 22, 1843, and has had its orbit carefully investigated by Carl Möller. It has been seen at each return since, and is at times tolerably bright, though not a naked-eye comet. Its motion agrees very closely with theory, and shows no trace of the effect of a resisting medium; but then it does not closely approach the sun.

To these may be added two lately discovered comets of similar period, which have not yet returned to perihelion after being discovered.

8. *Swift's Comet.*—Period 5·49 years; least distance from sun = 1·03; greatest distance = 5·00; last return, Nov. 6, 1880; next return, April, 1886. Discovered by Swift Oct. 10, 1880, and found to be identical with a comet discovered by Temple Nov. 27, 1869. It is tolerably bright, but owing to its proximity to the sun is only to be well seen at every alternate return.

9. *Denning's Comet.*—Period 8·72 years; least distance from sun = ·72: greatest distance = 7·55; last return, Sept. 13, 1881; next return, April, 1890. Discovered by Denning Oct. 4, 1881. Shown by Winnecke to be moving in an ellipse of short period, and supposed the same as that observed in 1855 by Hind. Tolerably bright.

Belonging to the same group, but of somewhat longer period.

10. *Mechain's Comet.*—Period 13·78 years; least distance from sun = 1·03; greatest distance = 10·51; last return, Dec. 2, 1871; next return, Sept. 1885. Discovered by Mechain Jan. 9, 1790, and rediscovered by Tuttle in 1858. It is faint.

Besides the above comets, 1743 (i) discovered by Grischau, 1783 (i) discovered by Pigott, 1819 (iv) discovered by Blainpain, and 1846 (vi) discovered by Peters, have been supposed to be comets moving in ellipses with periods of about five years, but have not been again observed. Comet 1770 (i), called Lexell's comet, has been shown to have had an elliptical orbit of 5½ years period, but its orbit lay so close to the planet Jupiter that the attraction of that body seems to have completely changed its orbit, so that though a bright comet it has never been again seen.

Nearly all the comets of this group (that is, of short period) are telescopic comets—that is, too faint to be seen without telescopic aid but under favourable opportunities. Encke's comet can be distinctly seen with the naked eye.

The comets of moderate period are some eight in number, most of them having orbits of about seventy years period, and with their aphelion distance close to the orbit of Neptune. They are—

Pechyle's, 1866 (i).	Period	53.	Next return about	1919
Hartwig's, 1880 (iv)	,,	62·3	,, ,,	1942
Westphal's, 1852 (iv)	,,	67·8	,, ,,	1920
Pons', 1812 (i)	,,	70·7	,, ,,	1883
Di Vico's, 1846 (iv)	,,	73·2	,, ,,	1919
Olber's, 1815 (i)	,,	74·0	,, ,,	1883
Brorsen's, 1847 (v)	,,	75·0	,, ,,	1922
Halley's	,,	76·8	,, ,,	1912

Of these the only one of any exceptional interest is Halley's. Most of the others are faint comets, though brighter than those of shorter period, and almost all were distinctly visible to the naked eye. Halley's comet, at some of its apparitions, has been exceptionally brilliant. The next brightest seem to be Hartwig's and Pons' comets.

Halley's Comet.—Period 76·00 years; least distance from sun = 0·59; greatest distance = 35·30; last return, Nov. 15, 1835; next return, 1912.

Halley's comet is famous as being the first whose periodical character was detected and whose return was duly predicted. The circumstances regarding the detection of its periodicity by Halley, whilst engaged on the study of the great comet of 1682, have been already mentioned. Owing to the investigations of Hind seventeen apparitions of this fine comet have been identified, and there can be little doubt that some of the most remarkable apparitions recorded are returns of Halley's comet. Thus the magnificent comet seen in 1066, and considered by contemporary historians as the prediction of the Norman Conquest, and the great comet of 1456, the precursor of the Wars of the Roses, were apparitions of this comet.

XXXIX.

Charles I. and the Long Parliament (*continued*).

An attack on the parliamentary cavalry by Prince Rupert at Brentford was the chief noteworthy fact of the close of the campaign of 1642; but in the next year operations were carried on more vigorously, various attempts at adjustment having failed; for neither side would

Battle of Brentford.

trust the other. A great misfortune befel the parliament in the death of Hampden, who was mortally wounded in the hot skirmish against Rupert's cavalry in Chalgrove Field. Hampden was a patriot of the type of Washington, unflinching in the service of his country, and without a particle of selfish ambition to mar the purity of his fame. The battles of Atherton Moor, June 30th—a royalist victory, Cromwell's triumph at Grantham July 15th, the indecisive contest of Lansdown July 5th, that of Roundway Down, near Devizes, July 13th, the taking of Bristol by Prince Rupert July 27th, and of Gloucester by the king August 10th; with the battle of Newbury in Berkshire, September 20th, in which Lord Falkland was slain, are the chief military events of 1643.

Chalgrove Field; death of Hampden.

A most important event was the forming of the Solemn League and Covenant between the parliament and the Scots in September of this year, for the extirpation of "Popery, prelacy, superstition, heresy, schism, and profaneness; and to maintain the rights and privileges of parliament, together with the king's authority, etc." Those of the clergy who refused to sign the covenant were compelled to give up their livings.

Covenant between Parliament and the Scots.

The battle in which the "beginning of the end" of this great contest could be plainly seen was that of Marston Moor, on the 2nd of July, 1644. Here Cromwell not only showed his high qualities as a commander, but also the infinite superiority of his steady and disciplined cavalry over the brave but unmanageable hordes of Prince Rupert. So great was the confidence inspired in the Ironsides by Marston Moor, that after that battle they marched against the enemy with a fierce enthusiasm and a consciousness of strength that went far towards ensuring triumph.

Battle of Marston Moor: its importance.

During these years of warfare the army had naturally been of paramount importance; and the leaders had gradually so far increased in power that a jealousy arose in the parliament lest they should overawe its deliberations, an anxiety proved by subsequent events to be well grounded. The Self-denying Ordinance was therefore brought forward at the end of 1644, and passed some months afterwards. It set forth that no man was to sit in parliament and hold military command. But as the services of Cromwell were considered indispensable, he was appointed to the chief command of the cavalry, and allowed to retain his seat in the house; and thus the chief intention of the ordinance, the restraining the ambition of military leaders, was frustrated.

Self-denying Ordinance.

At Naseby, near Market Harborough, was fought the decisive battle of the Civil War, on the 14th of June, 1645. Here the king was present in person, with his two nephews, Rupert and Maurice, and his most trusted commander, Sir Marmaduke Langdale. On the opposite side, the best of the parliamentary chiefs were also in the field: Cromwell, Fairfax, and Ireton, with Skippon and Colonel Pride to bring up the reserves. It was Cromwell who carried off the honours of the day, by vanquishing first the enemy's left wing under Langdale, and then driving in the centre, under the king himself. The private papers of Charles, which fell into the hands of the victors after the battle, contained ample proofs that his policy consisted in negotiating with all parties, and settling with none; and that his hope was to crush his enemies in detail.

Decisive battle of Naseby, 1645.

The Marquis of Montrose, one of the most active of the king's partisans, had meanwhile been fighting for Charles in Scotland, at the head of a mingled Scottish and Irish force. Victorious at Tippermuir, near Perth, he took Aberdeen, entered Argyleshire, defeated the Earl of Argyle at Inverlochie, and took Dundee. The subsequent victories of Auldearn, Alford, and Kilsyth seemed to promise him undisputed sway in the north: but all was lost by the one great defeat of Philiphaugh, near Selkirk, September 13th, 1645, by which Montrose's force was annihilated. The next year Montrose escaped to the Continent; but alternately returning, to renew the war, was captured and hanged in Edinburgh, professing that he died joyfully in the cause.

Montrose in Scotland.

Fate of Montrose.

In 1646, after the defeat of Lord Astley, whose force of 3,000 men was completely cut to pieces at Stow-on-the-Wold, the king's affairs were desperate. A Scottish army was encamped at Newark; for by the League and Covenant the Presbyterians of the north had agreed to furnish the parliament with an army, to be paid by the latter. Charles determined to put himself into the hands of the Scots, and accordingly rode into their camp in disguise. But the leaders received him, not as a royal guest, but as a prisoner; and after compelling him to write to the governors of the places that still maintained the contest for him, to surrender, negotiated with the parliament, offering to give up the king on receiving in different instalments a sum of £400,000, which they alleged to be due to them as pay. To these terms the parliament agreed, and in January 1647 Charles was delivered by the Scots to the parliamentary commissioners; and was soon after established as a prisoner in his house of Holmsby in Northamptonshire.

Charles in the Scottish camp at Newark.

The king delivered up to the parliament.

Meanwhile, the breach between the army and the parliament was growing wider, and an order was given that the army should be disbanded. The Presbyterian portion was dealt with easily enough; but the Independents, under Cromwell, Ireton, and Fairfax, refused to disperse, and petitioned parliament, in a threatening manner, for arrears of pay. The Presbyterian members determined to arrest Cromwell, who was the chief of the Independents, and he betook himself to the army, who received him with shouts; and from this time he became the head of the army

Quarrel between army and parliament.

against the parliament, or at least against the great majority in it. By his orders Cornet Joyce marched to Holmsby and took possession of the king's person. Soon after, the army chose Cromwell as its chief. The city of London, at first on the Presbyterian side, negotiated with him as he approached London; and at length the speakers of the two houses, with a number of the members, met the army on Hounslow Heath, and put themselves under its protection. The triumph of Cromwell and the army was complete. The king, meanwhile, had been living in a kind of honourable captivity at various places, including his palace of Hampton Court; and it was hoped he would come to an agreement with the army. But fresh suspicion was caused by his duplicity; and suddenly he fled to the Isle of Wight, to Colonel Hammond, the governor, who brought him as a prisoner to Carisbrook Castle. Baffled in renewed attempts to come to terms with the army, Charles signed a secret treaty with the Scotch force. He bound himself to abolish episcopacy, if they would reinstate him.

Advancement of Cromwell.

Charles I. at Carisbrook Castle.

The secret treaty produced no good fruit for the king; for though the Scottish army entered England, and the royalists under Sir Marmaduke Langdale were in arms in the north, Cromwell gained a victory over Langdale, at Preston, in August 1648, and defeated the Scots under the Duke of Hamilton a few days later at Uttoxeter.

Sir Marmaduke Langdale defeated

GREAT SEAL OF CHARLES I.

The strife between the Presbyterians in the parliament and the army became more embittered than ever. When the former sent commisioners to Newport in the Isle of Wight to treat with Charles, the army remonstrated against any accommodation with the king, and clamoured for "justice" upon him for his crimes. At the beginning of December, having possessed themselves of the king's person, and removed him to Hurst Castle, the army came to London to overawe the Presbyterians. After this there was not even the appearance of judicial impartiality. A Colonel Pride stood at the door of the Parliament House and prevented the Presbyterian members from entering. By this proceeding, known as "Pride's Purge," the assembly was cleared of eighty-one members who would probably have been favourable to the king; and Cromwell and the army had the whole game in their hands. The famous Long Parliament was now indeed fallen; among the expelled members was the fearless Prynne, who had suffered so heavily in purse and person for the cause of liberty; the small assembly of senators, belonging to the sect of the Independents, was nicknamed the Rump Parliament, and under that name they became the subject of endless ridicule in the cavalier songs. It was determined to bring the captive king to trial, before a High Court of Justice constituted for the purpose, on a charge of high treason, for having levied war against the parliament. On the 17th of January, 1649, Charles, who had been removed from Hurst Castle to Windsor, was brought to London; and the next day the High Court of Justice, with Bradshaw as its president, assembled to try "Charles Stuart" for treason.

The king in captivity.

Pride's Purge.

Trial of the king.

The king denied the legality of the court, declaring that the commissioners were manifestly not true peers of a king, and therefore incompetent to try him. Four times the captive was brought before the court; and his bearing was one of such quiet nobility and dignity, that among those who had been most exasperated at his former tyranny there were many now ready to invoke a blessing on that grey discrowned head.

That Charles should be found guilty was a foregone conclusion; but that the court dared, not only to condemn him to death, but publicly to execute the sentence, caused a general feeling of astonishment and horror. The dignified bearing of the captive, his meekness under suffering and obloquy, his magnanimous patience and endurance, turned the hearts of the nation towards him once more. Lord Macaulay has rightly designated the trial and condemnation of Charles as not only a crime on the part of his enemies, but a blunder. It was a crime because the proceeding was utterly unconstitutional and altogether against the laws of England; a blunder because, as the same great authority says, by putting Charles to death, his enemies set "the king" free. From that fatal 30th of January, 1649, when the head of Charles the First fell beneath the stroke of the man in the mask in front of Whitehall, every right and prerogative the dethroned

Execution of Charles; its effect.

monarch had possessed descended to his eldest son; and while the great reconciler, Death, caused the faults of the one to be condoned, the feeling of loyalty was transferred with renewed strength to the other. The beheading of Charles was the first step towards the Restoration.

Charles was forty-eight years old at the time of his death; but care and sorrow had prematurely aged him. Hallam, who on the whole appears to have judged his character with great fairness and impartiality, is of opinion that in private life he would have been "not altogether an amiable man, but one deserving of general esteem; his firm and general virtues the same, his deviations from right far less frequent, than upon the throne. It is to be pleaded for this prince, that his youth had breathed but the contaminated air of a profligate and servile court, that he had imbibed the lessons of arbitrary power from all who surrounded him, that he had been betrayed by a father's culpable blindness into the dangerous society of an ambitious, unprincipled favourite." How many of Charles's errors are to be ascribed to the evil influence of Buckingham, can only be conjectured; that he completely mistook the temper of the people he was called upon in troublous times to rule is certain. His want of sincerity was one of his greatest faults, and undoubtedly the one that led most directly to his ruin.

GREAT SEAL OF CHARLES I.

GERMAN.

XL.

STUDY FOR READING AND PRONUNCIATION.

Schweizer Hirtenleben.

shvy'-tser heerr'-ten-lay'-ben

SWISS HERDSMAN LIFE.

Die Berner[1] Alpen sind die schönsten
dee bairn'-er al-pen zint dee shoen'-sten
The Bernese Alps are the most beautiful

der Schweiz[2]: sie scheiden den Kanton
dare shvytz zee shy'-den dane kan-tone'
of (in) Switzerland; they divide the canton

Bern von Wallis und stoßen[3] an die Alpen
bairn fon val'-lis unt sto'-sen an dee al'-pen
Berne from Wallis, and are joined to the Alps

von Unterwalden,[4] Freiburg und Waadt. Das
fon un'-ter-vald'-en fry'-burg unt vaht das
of Unterwalden, Freiburg and Vaadt. The

Thal von Meyringen öffnet sich dem
tahl fon my'-rin-gen oeff'-net zich dame
valley of Meyringen opens itself to the

Reisenden, der Interlaken und Brienz
ry'-zen-den dare in'-ter-lak'-en unt bri-ents'
traveller, who Interlaken and Brienz

verlassen,[5] um sich nach Wallis zu
fer-las'-sen um zich nach val'-lis tsoo
quitted in order himself to Wallis to

begeben.[6] Es ist eine der malerischsten
be-gay'-ben es ist i'-ne dare mah'-ler-ish-sten
betake. It is one of the most picturesque

Gegenden der Schweiz; dort schäumt
gay'-gen-den dare shvytz dort shoemt
regions of Switzerland; there foams

der reiche
dare ry'-che
the rich

Wasserfall von
vas'-ser-fall fon
waterfall of

Reichenbach. Die
ry'-chen-bach dee
Reichenbach. The

Heerden welche
hare'-den vel'-che
herds which

im Herbste von
im hairb'-ste fon
in autumn from

den Hochalpen
dane hoch'-alp-en
the High Alps

herabkommen,
her-ap'-kom'-men
come down,

bringen[7] einen
bring'-en i'-nen
pass a

Theil des Winters auf diesen Weideplätzen
tile des vin'-ters orf dee'-zen vy'-de-plet'-sen
part of the winter on these pasture places.

zu. Die kleinen Sennhütten[8] bieten ihnen
tsoo dee kly'-nen zenn'-hüt-ten bee'-ten ee'-nen
The little herd-huts offer to them

ein Schutzdach[9] gegen die Kälte, welche
ine shuts'-dach gay'-gen dee kel'-te vel'-che
a shelter against the cold, which

zu heftig ist, als daß man die Kühe
tsoo heft'-ich ist als dass man dee kue-e
too violent is, than that one the cows

während der Nacht draußen lassen könnte.
vay'-rend dare nacht drow'-sen las'-sen konn'-te
during the night outside leave could.

In diesen Niederungen erwarten sie
in dee'-zen nee'-der-ung'-en er-vart'-en zee
In these lowlands await they

die Zeit der Rückkehr[10] in ihre Heimat.[11]
dee tsite dare ruek-care in ee'-re hy'-maht
the time of the return into their home.

Im Grase lagernd[12] und wiederkäuend,[13]
im grah'-ze lah'-gernd unt vee'-der-koy'-ent
In the grass resting and ruminating,
oder auf Felsen und Brücken sitzend
oh'-der owf fel'-zen unt bruek'-en zits'-end
or on rocks and bridges sitting,
blicken sie nach den hohen Weiden, wo
blik'-en zee nach dane ho'-en vy'-den vo
glance they at the lofty pastures, where
sie ihre schönsten Tage unter freiem
zee ee'-re shoen'-sten tah-ge un'-ter fry'-em
they their finest days under free
Himmel zubringen.
him'-mel tsoo'-bring-en
sky pass.

Vielleicht ist der Hirte selbst nur
feel-lycht' ist dare heer'-te zelbst noor
Perhaps is the herdsman himself only
ein Verbannter[14] in diesen tiefen Thälern;
ine fer-bann'-ter in dee'-zen teef'-en tay'-lern
an exile in these deep valleys;
er liebt seinen Berg und seine Senn-
airr leept zy'-nen bairg unt zy'-ne zenn'-
he loves his mountain and his herd-
hütte, wie der Matrose das Meer und das
huet-te vee dare ma-tro'-zeh das mair unt das
hut, as the sailor the sea and the
Schiff. Und sobald der Frühling die
shiff unt zo'-bald' dare frue'-ling die
ship. And so soon (as) the spring the
Alpen grünen macht, treibt er heitern[15]
al-pen gruen'-en macht trypt airr hy'-tern
Alps turn green makes, drives he cheerful
Sinnes die Heerde auf die Höhe. Hat er
zin'-nes dee hair'-de owf dee hoe'-e hat air
of mood the herd on the height. Has he
sich auf den Weg gemacht,[16] wie der
zieh owf dane vaich ge-macht' vee dare
himself on the way betaken like the
Hirte, von dem wir hier ein treues
heer'-te fon dame veer here ine troi'-es
herdsman, of whom we here a true
Bild sehen, so wirft er noch einen
bild zay'-en zo veerft air noch i'-nen
picture see, so throws he yet a
liebevollen Blick auf das Haus, wo sein
lee'-be-fol-len blik owf dass house vo zine
loving look on the house where his
alter Vater ihm den kleinen Sohn hütet;[17]
al'-ter fah'-ter eem dane kly'-nen zone hue'-tet
old father him the little son guards;
vielleicht sieht er sie auch unter dem
feel'-lycht zeet airr zee auch un'-ter dame
perhaps sees he them also under the
entlaubten[18] Kirschbaum oder gewährt
ent-lowp'-ten keersh'-bowm oh'-der ge-vairt'
leafless cherry-tree or descries
er den Rauch, der aus dem Dache
air dane rowch dare ows dame da'-che
he the smoke that out of the roof
der Hütte steigt, wo man Mahlzeit hält
dare huet'-te stygt vo man mahl'-tsite hellt
of the hut rises, when one mealtime keeps
und ihn sicherlich vermißt. Noch einige
unt een zich'-er-lich fer-mist' noch i'-nige
and him certainly misses. Yet a few
Schritte, und der Felsvorsprung[19] entzieht
shrit'-te unt dare felz'-fore-sprung ent-tseet
steps, and the rocky promontory withdraws
ihm das geliebte Bild: er steht
eem dass ge-leep'-te bilt air stayt
from him the beloved picture; he stands
allein auf hoher Alp mit seiner Heerde.
al-line' owf ho'-er alp mit zy'-ner hair'-de
alone on high Alp with his herd.

Der athletische Mann trägt auf seinen
dare at-lay'-tish-e mann traycht owf zy'-nen
The athletic man carries on his
Schultern all sein Geräth. Er hält mit
shool'-tern all zine ge-rate' air helt mit
shoulders all his utensils. He holds with
der einen Hand den Melkkübel und
dare i'-nen hant dane melk'-kue-pel unt
the one hand the milk-pail and
stützt sich auf den Stock mit der
stuetst zich owf dane stock mit dare
supports himself on the stick with the
eisernen Spitze, die in der sehnigen[20]
i'-zer-nen spit'-ze dee in dare zay'-nich-en
iron point, which in the nervous
Faust eine gefährliche Waffe werden
fowst i'-ne ge-fare'-liche vaf-fe vair'-den
fist a good dangerous weapon become
könnte. In einer hohen Bütte trägt er
koen'-te in i'-ner ho'-en buet'-te traycht air
might. In a high basket carries he
den Milchseiher mit der Buttermilch,
dane milch'-zy-er mit dare but'-ter-milk
the milk-pot with the buttermilk,
den Schämel, auf welchen er sich beim
dane shay'-mel owf vel'-chen air zich bime
the stool on which he himself at
Melken setzt, die Käseform, den Dreifuß,
melk'-en zetst dee kay'-ze-form dane dry'-fooss
milking sits, the cheese-form, the tripod,
in welchem jene abtropfen, und endlich
in vel'-chem yay'-ne ap'-trop-fen unt ent'-lich
in which these drip off, and finally
den großen Kessel, in welchem man die
dane gross'-en kes'-sel in vel'-chem man dee
the great kettle in which he the
Milch kalt werden und gerinnen[21] läßt.
milch kalt vair'-den unt ge-rin'-nen lest
milk cold become and run lets.

REMARKS ON THE FOREGOING STUDY.

[1] The names of towns can be used in the adjective form, with the endings corresponding with the noun. Thus—*die Londoner Zeitung*, the London newspaper.

[2] The majority of the names of countries are neuter—as *Frankreich*, France; *Deutschland*, Germany; *Norwegen*, Norway. Switzerland and Turkey, *die Schweiz* and *die Türkei*, are feminine.

[3] The verb *stoszen* is literally to push or thrust (impf. *ich stiesz*, past part. *gestoszen*).

[4] *Unterwalden* means literally, under or among the woods.

[5] After *verlassen* the verb *hat* is here understood—"who has quitted"—*verlassen* being here the past participle.

[6] *Sich begeben* is a reflective verb: *Ich begebe mich nach London*, I betake myself to London; *er begab sich nach Rom*, he betook himself to Rome.

[7] *Zubringen* is a reflective verb, and is used for time, in the meaning "to pass," or "spend." *Er brachte ein Jahr in Hamburg zu*, he spent a year in Hamburgh.

[8] *Senne* is a name given to the Alpine herdsmen. The *Sennhütten* are wooden sheds erected on the Alps.

to give shelter to the herdsmen. *Der Senne musz scheiden, der Sommer ist hin* (the herdsman must depart, the summer is gone) occurs in Schiller's *Wilhelm Tell.*

[9] *Schutzdach*, from *schützen*, to protect, and *das Dach*, the roof (whence *deck*).

[10] *Die Rückkehr*, the return; from *rücken*, back, and *kehren*, to turn.

[11] *Die Heimat* means the home, not in reference to a house, but to a native country or place.

[12] *Lagern*, to lie down to rest; hence *das Lager*, the camp. *Lager* is also used in the sense of a place of deposit; *das Waarenlager*, the storehouse or magazine for goods.

[13] *Wiederkäuend*, ruminating; from *wieder*, again, and *kauen*, to chew.

[14] From *verbannen* comes the English word "banish." The German *ban* originally meant a summons to appear or assemble—as, *der Heriban*, the summons to the army.

[15] *Heitern* is here an abbreviation of *heiteren*, the genitive of *heiter*, cheerful.

[16] *Sich auf den Weg machen* is an idiomatic expression meaning to start on a journey (*se mettre en chemin*).

[17] *Hüten*, to guard; from *die Hut*, care or heed. *Hüte dich*, take heed to thyself.

[18] *Entlaubt* is literally "unleaved," deprived or denuded of leaves.

[19] *Der Felsvorsprung*, the promontory; literally from *Fels*, rock, and *der Vorsprung*, the start or space in advance.

[20] *Sehnig*, from *die Sehne*, the sinew.

[21] *Gerinnen* means to run into a mass or curdle.

Exercise on the Foregoing Study.

(The sentences to be translated into German and corrected by the German version that follows them.)

The beautiful Bernese Alps divide the Canton Berne from Wallis, in Switzerland. When the traveller has quitted Interlaken and Brienz, opens itself to him the valley of Meyringen The region is very picturesque, with the rich foaming waterfall of Reichenbach. The herds come down in the autumn from the high Alps. The little herd-huts offer the herdsmen a protection against the violent cold. Then comes the time when they return to their home.

The herdsman loves his mountain and his herd-hut, as the sailor loves his ship and the sea. He drives the herd to the height when the spring comes and the Alps become green. He sets out (macht sich) on his way, but throws a glance back on the house where he sees the smoke that rises from the roof of the hut where his old father and his little son dwell. And now he stands alone, with his herd on the high Alps, and sees the beloved picture of his home no more.

The herdsman must be a strong athletic man; for in the high basket he carries at his back the utensils of his trade. From the milk of his cows he prepares cheese, which is highly esteemed in Switzerland and in other countries. He supports himself upon a stick with a long iron point, and strides sturdily forward although he is so heavily laden. Among other things, he carries a great iron kettle.

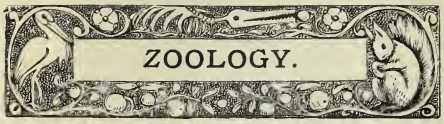
German Version, to be used in correcting the exercise, and for reading.

Die schönen Berner Alpen scheiden
dee shoch'-nen bairn'-er al'-pen shy'-den
den Kanton Bern von Wallis in der
dane kan-tone' bairn fon val'-lis in dare
Schweiz. Wann der Reisende Interlaken
schvyts vann dare ry'-zen-de in'-ter-la-ken
und Brienz verlassen hat, öffnet sich
unt bri-ents' ver-las'-sen hat oeff'-net zich
ihm das Tahl von Meyringen. Die Gegend
eem dass tahl fon my'-rin-gen dee gay'-gend
ist sehr malerisch mit dem reichen
ist zayr mahl'-er-ish mit dame ry'-chen
schäumenden Wasserfall von Reichenbach.
shoi'-men-den vas'-ser-fall fon ry'-chen-bach
Die Heerden kommen im Herbste von
dee hairr'-den kom'-men im hairbs'-te fon
den Hochalpen herab. Die kleinen Senn-
dane hoch'-alpen her-ap' dee kly'-nen zen'-
hütten bieten den Hirten einen Schutz
huet-ten bee'-ten dane heert'-en i'-nen shutz
gegen die heftige Kälte. Dann kommt
gay'-gen dee hef'-ti-che kel'-te dann kommt
die Zeit wo sie in ihre Heimat zurück
dee tsite vo zee in ee'-re hy'-maht tsoo'-ruck
kehren.
kay'-ren

Der Hirte liebt seinen Berg und seine
dare heer'-te leebt zy'-nen bairg unt zy'-ne
Sennhütte wie der Matrose sein Schiff
zenn'-huet-te vee dare mah-tro'-ze zine shiff
und das Meer liebt. Er treibt die Heerde
unt dass mair leept air trybt dee hair'-de
auf die Höhe, wann der Frühling kommt,
onf dee hoe'-e vann dare fruch'-ling kommt
und die Alpen grün werden. Er macht
unt dee al'-pen gruen vairr'-den air macht
sich auf den Weg, aber wirft einen
zich onf dane raich ah'-ber veerft i'-nen
Blick zurück, auf das Haus wo er den
blick tsoo-ruck onf dass house vo air dane
Rauch sieht, der von dem Dache der
rowch zeet dare fon dame da'-che dare
Hütte steigt wo sein alter Vater und
huet'-te stycht vo zine al'-ter fah'-ter unt
sein kleiner Sohn wohnen. Und jetzt sieht
zine kly'-ner zone voh'-nen unt yetst stayt
er allein, mit seiner Heerde auf hoher
air al-line' mit zy'-ner hair'-de onf ho'-er
Alp, und erblickt das geliebte Bild seiner
alp unt er-blicht dass ge-leep'-te bild zy'-ner
Heimat nicht mehr.
hy'-maht nicht mair

Der Hirt muß ein starker athletischer
dare heert muss ine stark'-er att-lay'-tish-er
Mann sein; denn in der hohen Butte trägt
mann zine denn in dare ho'-en but'-te trayeht
er auf dem Rücken des Geräth seines
air onf dame ruck'-en dass ge-rate zy'-nes
Gewerbes. Von der Milch seiner Kühe
ge-vair'-bes fon dare milch zy'-ner kue'-e
bereitet er Käse, welcher in der Schweiz
be-ry'-tet air kay'-ze vel'-cher in dare shvyts
und in andern Ländern (im Auslande)
unt in an'-dern lend'-ern im ow'slan-de
hoch geschätzt wird. Er stützt sich auf
hoach ge-shetst' veert air stuetst zich onf
einen Stab, mit langer eisernen Spitze,
i'-nen stahp mit lang'-er i'-zer-nen spit'-se
und schreitet rüstig vorwärts, obgleich
unt shry'-tet ruest'-ich for'-vairts op-glyeh

er ſo ſchwer beladen iſt. Unter andern
air zo shvair be-lah'-den ist un'-ter an'-dern
Dingen trägt er einen großen eiſernen
ding'-en traycht air i'-nen gross'-en i'-zer-nen
Keſſel.
kes'-sel



XIII.

LEMURS (*continued*).

A GROUP of squirrel-like Lemurs which has no convenient English name, and is called Cheirogale, is only active during the productive rainy seasons, taking a long siesta in the dry, hot weather. While this lasts they are very slowly breathing, and using up little by little the stores of food, chiefly fat, which have been gained by the tissues of the body during the feeding season. When in full activity they jump most perfectly, the long bones of the hinder part of their feet giving great power to the muscles of the calf. They see and feel most exquisitely with little or no light. Some of the smaller forms weave nests of twigs, while others conceal their young in tree-clefts and hollows.

Squirrel Lemurs.

One of the West African Galagos has been most felicitously described as "a very epitome of zoology, of the size and colour of a large rat; it had the tail of a squirrel, the facial outline of the fox, the membranous ears of the bat, the eyes and somewhat the manners of the owl in its cool odd way of peering at objects, the long slender fingers of a lean old man, who habitually eats down his nails, and all the mirthfulness and agility of a diminutive monkey." The Galagos, some species of which are as large as a cat, range over both western and eastern Africa, some reaching to the White Nile, the Blue Nile, and Nyassa, others inhabiting Senegal. They are remarkably rapid and successful in their movements, especially in capturing insects, their eyes and ears serving them well: indeed, the ears are very striking features, and some of them can crumple up the external earlobe at pleasure.

Galagos.

There is a group of African Lemuroids which afford a strong contrast to all we have described; they are as slow and dull as the others are agile and clever. It is a question whether they deserve this character, for they are very little known in their natural abodes and night travels. The Potto of the Gold Coast and Guinea, and a few other African forms, find neighbours in structure in the Indian and Malayan creatures called Loris, some of which, as the Ceylon Sloth, are sufficiently lithe and nimble at night.

The slow Lemurs.

The Malmag, whose home is in the Malayan archipelago and the Philippine islands, is an uncanny animal to the natives, who are frightened at its great eyes; yet it is but a small creature — its body six inches long. It has characteristics sufficient to make it represent a distinct family in itself, no other similar creature being known. It has four incisor teeth in the upper jaw, but only two below; and it is notable for the elongated sole of the foot, which becomes divided into two sections, the hinder or heel-portion being much lengthened and constituting an additional joint to the leg. Its most favourite food is lizards.

The Malmag.

The Aye-Aye is a Madagascar animal, very different from the ordinary Lemurs; yet no other group can fitly receive it. The pair of great gnawing teeth occupying the front of both jaws, growing as they are worn, and covered with a thick coat of hard enamel in front, so that they wear into a chisel shape; and the peculiar hands, of which the first digit is not a perfect thumb, while all the fingers are lengthened and skeleton-like, especially the middle one, constitute sufficiently strange characters when compared with any animals we have yet studied. Dr. Sandwith has well described the special use of these peculiarities. When the Aye-Aye finds a worm-eaten branch, he bends forward his sensitive ears, puts his nose close to the bark, rapidly taps the surface with the slender middle finger, from time to time inserting the end of the finger into the worm-holes, as a surgeon would a probe. If the sound is satisfactory, he tears the branch with his strong teeth, strips off the bark, cuts into the wood, and exposes the nest of a grub which he picks out with the slender finger, and eats. He has a very curious mode of drinking, by passing a finger through water and so getting it into his mouth that the water appears to be flowing in a constant stream. The third finger is also used to cleanse the face most thoroughly, the other fingers being meanwhile closed. Their eyes are excellently suited for night-work, which, again, has to a large extent prevented many of their habits from becoming known.

Teeth of Aye-Aye.

Aye-Aye grub-hunting.

Here we part from the group of animals nearest allied to man. In its lower division it gives us glimpses of many unsolved problems —the long persistence of peculiar types of animals in distant parts of one geographical province; the shutting up, as it were, of these types in large islands or special kinds of forests, —the extent of old continents. The variety of forms we have dwelt upon is but a sample of what is to be found in almost every group of animals; far more remains to be disclosed than is already known.

THE CARNIVORA.

The group classed as Carnivores, or flesh-eaters, although many of them live on fruits, includes animals which, above all others, excite the imagination and interest of mankind. Lions, tigers, leopards, lynxes, hyenas, panthers, pumas, jaguars, wolves, bears, are creatures as universally admired for their beauty and power, as they are dreaded for their rapacity and

Principal qualities.

cruelty under certain conditions. Inasmuch as they largely depend upon the superfluous animal population of the globe for the means of subsistence, they share with man, so far, the necessity of subduing the earth ; while, on the other hand, since they do not resemble man in their capability of increasing the productiveness of the soil, it is probable that at some time they will become entirely extinct, with the possible exception of the cat and the dog, which to some extent are able to assimilate themselves to the habits and minister to the needs of man's domestic life. The dog in particular shows an intense amount of variability both in size and proportions, with useful special qualities akin and even superior to those exhibited by the ox, sheep, and pig, and possibly only approached by the horse. Thus, independently of the interest naturally centring about the achievements of the great freebooters of this order, there is a human problem of a most absorbing nature in the powers and possibilities of the dog.

Interest to man.

To mention a few general characteristics, notice the hairy covering and the looseness of skin in most. The dog is thus able, with the aid of his skin-muscle, to shake himself free from water. The body is longer than it is high, the attitude being habitually quadrupedal, presenting no approach to the erect posture found in man and some man-like apes. The head is carried quite in front of the neck, though somewhat raised above its level, and the face, or that portion including the jaws and snout, is in front of the brain-case. In the long and low skull the brain-space is comparatively small, while the arrangements are such that the utmost space is gained for large muscles which, having their main bulk far back, get a powerful leverage upon the lower jaw, and so open and close it rapidly, and hold the prey with extreme tenacity, while the forcible withdrawal of the head, the fore-paws retaining the mass firmly, completes the tearing and wrenching process.

General characters.

The teeth, whether canines of a sharp curved conical form, or molars with sharp prominences, are in the flesh-eaters highly adapted to seizing and cutting and penetrating animal prey.

Teeth.

Flexibility is especially provided for in the form of the bones and the construction of the joints. Moreover, the muscles are attached to them at such angles and in such positions as to give the springing and the striking power combined in a most effective degree. The last joints of the digits usually possess curved and sharp-pointed claws, lodged in sheaths or cavities excavated above the last bone of the digit, which is similar in shape. In the most ferocious forms the claw is almost entirely concealed until the moment of action, when the act of striking and the projection of the claw into the flesh of the victim are simultaneous.

Powerful muscles and claws.

THE AYE-AYE.

There are many other matters in reference to the limbs in which very wide divergence exists among the Carnivora. For instance, the marine group, the seals and walruses, by the very simple addition of a web or fold of skin between the toes, and also connecting the hinder limbs and the tail, gain a most valuable adjunct for swimming. The cats, on the other hand, walk almost literally on tiptoe, carrying the hinder part of the foot as an addition to

their length of leg, which after all is comparatively short; noiseless movement is also most effectively secured by the soft padded cushions beneath the parts of the toes on which they walk. The bears again are distinguished for the flatness and extent of their feet: they are the typical plantigrades or sole-walkers. As we proceed it will be interesting to note how few quadrupeds or bipeds are so endowed as to be able to use the entire sole of the foot, right back to the heel, in walking. Those animals which have the whole foot in one plane are for the most part either scratchers and diggers, or swimmers.

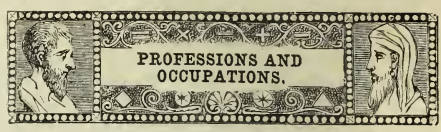
Mode of walking.

Size of head and acuteness of powers do not always go together. The most acute of the Carnivora certainly are not those with the largest head in proportion to the body. Nature can work as perfectly in the minutest compass as in the most extensive domain. Thus most of the feline race can see almost perfectly in the twilight or night-time, provided only there be some light. They possess an extra instrument of sight, an additional reflecting mirror, in their eyes, and thus catch and concentrate rays which would be scattered or useless without it. Their brain, too, has considerable complication in its folds, but we cannot trace a direct connection between acuteness and size of brain in them, although as a general rule, in the principal orders of animals there is observable a clear progression in brain structure throughout the scale which we regard as the ascending one. Both the senses of hearing and smell have extremely good organs—of a smaller size than in many other creatures, however; and as if to illustrate the extent of the inexplicable in nature's workings, we find in this order the creatures with most complex foldings of brain are those dwelling habitually in the sea, and these at the same time are unprovided, or almost unprovided, with external ears. Finally, let us note that the small comparative size of the abdomen in the Carnivora, especially in the flesh-eaters of the group, means that the stomach and intestine are not lengthened or elaborate in structure, this being unnecessary when the food is so concentrated and nutritious as theirs is.

Acute senses.

Reluctantly we must limit our notices of individual members of this most interesting group. The lion and the tiger are at once acknowledged supreme in the order, which extends almost over the whole of the habitable globe, except Australasia, Madagascar, and New Zealand. The cat family, to which they belong, furnishes powerful beasts in most countries. Even in our own land the wild cat is not yet extinct; and in past times the cats were abundant, and had for superiors the great cave lion, the great hyæna, and many other large creatures, which have already been extirpated by the increase of man in numbers and skill. One of the most remarkable of these has been named machairodus, or the sabre-toothed, from the great size and peculiar shape of the upper canine teeth, which extended quite to the chin when the mouth was closed.

The cat family.



THE BAR.

II.

Qualifications for Call.

We shall now describe briefly the manner in which the law student developes into a full-blown barrister-at-law. To do this he must fulfil the following conditions: (1) keep twelve terms; (2) pass an examination in Roman law; (3) pass an examination in English law; besides which he must be of age before he can be "called," *i.e.* formally admitted a member of the Bar. There are four terms in each year, so that rather less than three years is the minimum period which must elapse between admission to the Inn and "call." There is no obligation to keep all or indeed any terms in each year—it is only necessary to keep any twelve terms at the student's convenience, and a term once kept counts for all time as one out of the required twelve. Nor is there any maximum limit to the time which may be spent as a student. Indeed, it frequently happens that Indian civil servants, and other persons obliged to go abroad before they have kept the whole twelve terms, return after the lapse of ten or twelve years, and take up the thread of term-keeping just where it was broken off.

The four "Inns of Court terms" are Hilary Term, in January; Easter Term, in April; Trinity, in June; and Michaelmas, in November; lasting about three weeks each. The exact days on which they commence and end are not the same in each year, but can be found by reference to any almanack. To "keep" a term, the necessary and sufficient condition is to dine in hall a certain number of days in the term. Members of a university are only required to dine *three* times—all others must dine *six* times. This is the sole method of keeping a term. Probably at one time there were other conditions, or at least when a journey from the country was a much more formidable thing than it is now, and restaurants and clubs did not exist, the obligation of dining together implied a much greater degree of social intercourse than it does now. The object, no doubt, was not only to bring students together, but to bring the whole body of students into frequent contact with the Bar—for it is to be remembered that to this day a considerable number of barristers of eminent position at the Bar dine regularly in hall during term, and in old times the custom was still more honoured,—when the hours of work were not so long, and the Temple did not empty itself into the suburbs every evening at five o'clock. Whatever these conditions at one time were, they have all disappeared with the exception of the quaint and not very disagreeable one of eating a certain number of very good plain dinners in a magnificent mediæval dining-hall, at which a few old-fashioned observances are still kept up.

Dining at the Middle Temple.

Perhaps some of our readers would like to be present, in the spirit, at one of these dinners. We have much pleasure in introducing him as our invisible guest at the Middle Temple—regretting that the rules of the Inn prevent us bringing him in bodily and giving him a place at our "mess." The Hall in which we are to dine is at least as old as good Queen Bess, who is said to have danced at one of the merry revels which were common in the Temple then. The date 1574, in large figures, may be read on the great east window of stained glass. It is long, broad, and lofty. Inside there is black oak everywhere. The walls are of oak panels, on which are emblazoned the coats of arms of the various "readers," or lecturers, for centuries back. The large windows high up are also filled with the stained glass shields of the judges, chancellors, and great men who have been members of the Inn. The roof is of black oak beams cunningly wrought and fitted together.

At the lower end of the hall is a magnificently carved old oak screen, supporting a gallery in which musicians or spectators occasionally sit. At the other end is a raised dais, on which is the "Benchers'" table. They are the governing body of the Inn, and are all barristers of long standing. All down the hall are long tables, with bare benches on each side of them. At one of these we shall take our stand, as the hall is filling with students and barristers, each in their respective gowns—but not wigs. It is now a few minutes after six o'clock. There is a little stir at the entrance. A procession of benchers passes up one side of the hall. They range themselves along the dais, standing, and facing the body of the hall where the students and barristers who are not benchers stand at attention. Three waiters bring in three large dishes, with which they stand before the senior bencher. The head porter, in gorgeous robe of office, knocks three times, slowly and loudly, with a little hammer on the table. The senior bencher reads a long grace, amid perfect silence. Then there is a babble of tongues, a hurrying of waiters bringing in the dinner, a clattering of knives and forks, and we find ourselves seated on one of the bare benches at a long table stretching from end to end of the hall. The diners are divided into little parties of four, which are called "messes." Each mess has its own dishes, wine, etc., distinct from the rest—in fact forms a distinct dinner party. In each mess the person who happens to sit in a particular seat is "Captain" of the mess. He is master of the ceremonies. He orders the wine, and it as well as the dishes are set down before him. He helps himself first to whatever is set before him, and then passes it on to his left-hand neighbour, who helps himself, and in turn passes it on to the next in order, and so on; always, however, keeping to the one mess, and having no communication with neighbouring messes.

The dinner consists of (1) fish or soup, (2) joint and vegetables, (3) a sweet dish, and (4) cheese; beer, *ad lib.*, and one or two bottles of wine, according to the kind of wine selected from a choice of five or six different kinds.

When the wine is brought it is placed before the Captain, who, when he thinks fit, fills his own glass and passes the bottle round in the prescribed order, each member helping himself, but no one drinking till all have filled their glasses. Then the Captain lifts his glass; the other members of the mess do the same; each bows ceremoniously and gravely to the other three, and then at last each thirsty soul is at liberty to empty his bumper. When all have finished, the cloth is removed, the head porter again strikes thrice with his hammer on the table, the senior bencher says grace, and the procession of benchers passes down the hall, bowing as they walk to their acquaintances at the lower tables, and disappear into their common room, where, it is irreverently believed, they partake of coffee and cigars, and even maraschino!

The students are now free to leave the hall, with the contented feeling which a good dinner and the satisfaction of having performed a professional duty ought to inspire.

But, fortunately for his future clients, the student has sterner duties to perform. Before he has eaten many dinners, he becomes uneasily conscious that an examination must somehow be passed, and that eating dinners, however necessary, will never help him to answer a single question. He probably has begun to attend lectures in some branch of law in his very first term. There are excellent lectures in every branch, and though he is under no obligation to attend any of them, he will find it a great help and guide to do so. The examination, which *must* be passed before he can be "called," is divided into two parts—the first being in Roman law, and the second in English law. He may take both at the same time, or he may take the Roman law first, but he cannot take English law before the Roman. He may take the Roman law any time after he has kept *four* terms, but cannot take the English until he has kept at least *nine* terms.

The average student will probably be advised by his legal friends to get rid of his Roman law as soon as possible, and then to devote all his energies to the more practically useful English law. But this advice is liable to modification according to the particular circumstances of each student. We may take this opportunity of observing that the student will find it a great advantage to be able to consult some experienced friend as to his course of study, the examinations and prizes to be read for, and, above all, the general programme of his preparation for the profession.

Notice is given beforehand of the particular parts of each subject in which the student will be examined. In Roman law, the Institutes of Justinian—Sandar's edition—are generally set; and the student will find considerable help in the lectures on Roman law, as well as in some of the small text-books on the same subject, such as Greene's "Analysis of the Institutes."

English law consists of three branches.—(1) Common Law; (2) Equity; (3) Real and Personal Property.

A paper and a few questions *vivâ voce* are given in each of these branches ; the object being to test the student's acquaintance with the elementary principles of the *whole* of each subject, as well as a more minute acquaintance with certain specified *parts* of each. A thorough knowledge of the following text-books, supplemented by a course of lectures on each subject, will probably be sufficient preparation, but the student will do well to read other text-books if he can :—

Broom's "Common Law," Snell's "Equity," Williams' "Real Property," and the same author's "Personal Property," together with those "Leading Cases" which deal with the parts particularly set. This course might be mastered by a student of average intelligence, accustomed to read up for examinations, and with nothing else to occupy him, in (say) from four to six months of regular reading.

Specimens of the papers set at each examination, and the answers to them, can be seen in the "Bar Examination Journal."

Having passed this final examination, and kept his twelve terms, the student is now eligible to be "called." There are a few formalities to be gone through, which vary slightly at the different Inns, and which the student will learn from the Steward or sub-Treasurer of his Inn. He is "proposed" by a Bencher, at a meeting of the Benchers on "call day"—the sixteenth day of each term ; and having paid his fees, amounting in all to about £100, and having been personally presented to the Benchers, the student is transformed into a full-blown Barrister-at-law. The "call" is usually celebrated with some very mild festivities of a public nature, and sometimes with private festivities of a less mild character.

Honours, Prizes, etc.

We have now sketched out the necessary conditions which *must* be fulfilled by every student before he can be called. But in addition to the examinations already described, there are a great number of optional examinations, at which "honours" and money prizes can be won by competition. The money prizes, open to the competition of every student, irrespective of the Inn of which he is a member, amount to about £1,900 a year, while those given annually by each Inn, and restricted to its own members, vary from £375 at Gray's Inn, to £840 at the Middle Temple. These are given subject to certain conditions as to age, and the number of terms kept by the student,—too numerous to be given here, but which can be learned at the office of any Inn. The chance of obtaining one of them depends on the student's abilities and diligence, and on the degree in which his rivals possess the same qualities; but the competition for them is by no means so keen as their value might lead one to expect. A diligent student of good abilities might, we consider, by taking a sufficient time to prepare, make almost sure of getting in his career two or three prizes varying in value from £20 to £100—a consideration to many students, though we earnestly warn every intending law student not to take any account of such a chance in "counting the cost" of the step he proposes to take.

There is also an examination for honours which the ambitious student may substitute, if he will, for the ordinary examination in Roman and English law above described.

Reading in Chambers.

So far we have considered that part of the law student's preparation which depends on books and lectures. But there is one part of his preparation for practice if possible more essential to his future success than this—namely experience of practical work. A man may have passed all his examinations with distinction, and have won a small fortune in prizes, and yet find himself absolutely helpless when "papers" are put into his hands and he is required to do even the simplest thing in conveyancing or pleading.

The experience in practical work which is absolutely essential to enable even a well-read student to do the simplest thing in practice can only be gained by actually doing such work. Of course no solicitor would or could allow his client's interests to be placed at the mercy of the *experiments* of a mere learner. The student must therefore serve an apprenticeship to his business. This is called "reading in chambers" with some barrister who has work of his own. The student becomes a "pupil" to some such barrister. Every "junior"—*i.e.* a barrister who is not a Q.C.—may take pupils. The fee paid by a pupil is one hundred guineas for a year, or fifty guineas for six months. No barrister will take a pupil for less than six months, and many will not take one for less than a year.

A pupil is of course at liberty to come to and leave chambers at what hours he pleases, but he will get little benefit unless he is regular, and spends the whole day—say from ten to four or five o'clock—at his work. The barrister with whom he reads gives him the whole set of papers which constitute "the case," and perhaps explains very briefly the nature of the thing to be done. The pupil then sets to work on these papers, exactly as if they were his own—to draw up a will, let us say, or a statement of claim in an action, or to write an opinion as to the rights of the parties and the law of the case. When the pupil has done his work to the best of his ability, he submits it to the barrister, who goes over it with him and corrects it.

For the first few months the pupil will probably feel discouraged by the regularity with which he finds his best efforts full of inaccuracies, or perhaps totally wrong. But gradually he will find the corrections made in his drafts fewer and less radical, giving promise of the day when they will have dwindled down to insignificant changes in the wording such as every conveyancer is certain to make in any other man's work.

The same barrister often has three or four pupils who work in a room devoted to their use. Here the beginner will find more experienced pupils, who will be glad to help him over his initial difficulties ; and from their conversation and discussions, if they are in earnest, he will learn not a little.

It is usual, and indeed most necessary, to read in chambers for more than one year, and with more than one barrister, in order that the pupil may become acquainted with all branches of practice; for after some years a barrister's practice is apt to become limited as to the kind of work,—as it increases in quantity it becomes limited in character.

The choice of a barrister with whom to read, and the time to be spent in reading in chambers, as well as the period of his career at which to commence doing so, and the order in which work of different kinds should be taken up, are very important matters—so important, and depending so much on the individual circumstances of each pupil, that we will not venture to lay down here any rules for the student's guidance in them, but recommend him to take oral advice from the most experienced and wisest of his friends. It is, however, almost undisputed that the first kind of practical work to be done is conveyancing; that if possible a year should be devoted to this branch, and at least another year to general equity practice or general common law practice, according as the student intends to devote himself to practice in one or the other branch.

As to the best age at which to commence his student's career, we should say from twenty to twenty-three. The student will then be from twenty-three to twenty-six when called—the former age not too young, and the latter not too old to begin actual practice; but men are often called at a later age.

There is no reason why preparation for the bar should not be preceded by a university education. There is plenty of time for both, if rightly gone about. While at a university the student can lay a good foundation in theoretical law, which will enable him to make more rapid and safer progress afterwards when he comes to the practical work. He can also, if it be thought desirable, become a law student and keep some of his terms before leaving the university, and thus shorten the three years of student life in London. It is to be remembered that a University student need only dine three times in each term in order to "keep" the term, so that his university career is not in any way interfered with by keeping law terms, and it may save much time and expense afterwards. Time is especially important to any one commencing his university life later than twenty-one, and saving of expense is often even more important.

We must now conclude, hoping that this brief sketch is sufficiently clear to enable the intending law student to understand what he must do, and to weigh roughly his chances of prospering.

For fuller details and more elaborate guidance we have great pleasure in recommending Mr. Walter W. R. Ball's excellent little "Student's Guide to the Bar," in which will be found advice and opinions as sound as they are clearly expressed.

HYDROMETER.

CHEMISTRY.

XXXVIII.

FERMENTATION (*continued*).

DURING the process of fermentation, which is continued after the wine is placed in casks, tartar, tartrate of lime and colouring matter is often deposited. The substance known as tartar being almost insoluble in wines containing a large proportion of alcohol, it follows that strong wines are much less acid than weak ones. In bottle the same changes take place as in the cask, though in a less degree. The wine deposits a crust, as it is termed, consisting of extractive colouring-matter and tartar, and in some cases crystals of tartrate of lime are met with. The bouquet is also greatly influenced by the time the wine is in bottle. Some wines may be kept in bottle not only in an unaltered but in an apparently improving condition much longer than others; of this class are sherry and Madeira. Port and some other red wines improve for a time and then appear to decline, losing colour and flavour. The bouquet of claret improves up to a certain point, but goes off if the wine be kept too long. Wine may be kept in bottle until it has quite lost the character and appearance of wine.

Fermentation in the cask.

Strong wines less sour than weak ones.

Wines in bottle.

Should not be left too long in bottle.

The class of sparkling or effervescent wines— "les vins mousseux" as the French term them—owe this property to the development of free carbonic acid in the wine when in bottle. The process is, however, always assisted by the introduction of foreign ingredients into the wine; and by careful manipulation any wine may thus be rendered *mousseux*, like champagne, ginger-beer, or lemonade, which effervesce as soon as the cork is removed owing to the escape of free carbonic acid from the liquid. The development of this gas is sometimes so rapid as to cause the bursting of the bottle, especially in hot weather.

Sparkling wines.

Effervescence due to escape of carbonic acid.

The strength of wine is of course due to the amount of alcohol it contains; at the same time the intoxicating power of a wine cannot be exactly estimated by its alcoholic strength. The effect of the alcohol of wine upon the system is doubtless greatly modified by the way in which it is blended with the other constituents of the beverage. Ardent spirits, such as brandy or whisky, even when diluted with water to the strength of wine, will be found to act more rapidly than the

Varying strength of wines.

latter in producing intoxication. The wine drinker is thus, on the whole, safer than the dram drinker. While the proportion of alcohol is as much as 25 per cent. in some examples of port and sherry, as well as in Marsala, Madeira, and other full-bodied wines of southern Europe, it will be found that the wines of France and Germany contain a much smaller quantity.

Proportion of alcohol in wines.

Pure alcohol, or as chemists term it "absolute alcohol," is commonly obtained by submitting rectified spirit to careful distillation and causing its vapour to pass through quicklime, dry carbonate of potash, anhydrous sulphate of soda, or some other substance having a strong affinity for water. The vapour of water being absorbed and retained by these substances, that which passes off is the vapour of pure alcohol, which is afterwards condensed to a liquid in a proper apparatus.

Production of pure alcohol.

Absolute alcohol is a clear, colourless liquid, having a less specific gravity than water, and boiling at about 173° Fahrenheit. It has never been frozen, but has been rendered too dense or viscous to pour out of a bottle by the action of a very low temperature. Its power of resisting cold renders it suitable for the construction of thermometers intended for use in the Arctic regions, as mercury freezes at —40° centigrade, or at 72° below freezing point Fahrenheit.

Nature of alcohol.

Alcohol has a very strong affinity for water, absorbing moisture when exposed to the atmosphere. There can be no doubt that these two liquids enter into very intimate union with one another, forming something of the nature of a chemical compound. The liquid obtained by mingling alcohol and water does not exactly represent the volume of each before mixing. For example, if a pint of alcohol be mixed with a pint of water, the compound thus formed will not exactly fill a quart.

Its affinity for water.

A mixture of alcohol and water.

Alcohol is very inflammable, burning with a pale blue flame, and giving rise by its combustion to carbonic acid and water. Proof spirit, as it is termed in commerce, contains about 55 per cent. of alcohol to 45 of water. This is accepted as the standard in estimating the strength of other spirituous liquors, which are said to be so many degrees above or below proof.

Proof spirit.

Before we proceed to speak of the processes of brewing and distillation, it is perhaps advisable to say a few additional words regarding the nature of a ferment. This has already been defined to be a nitrogenous compound which, when in a state of partial decomposition, possesses the property of converting grape sugar in solution into alcohol. The must or juice of the grape, and most other vegetable juices, contain a sufficient quantity of albumin to set up this action on exposure to the atmosphere, although in some cases it may be found necessary to add a certain proportion of ferment to the liquor. A ferment can, however, at any time be set up in a solution of pure glucose or grape sugar by the addition of a little yeast. If this process be carried on in a glass vessel it will be seen that the particles of the yeast (the ferment) become covered with bubbles of carbonic acid, which cause them to rise to the surface of the liquid, where on the bursting of the bubbles and discharge of the gas they again acquire sufficient specific gravity to sink until a fresh coating of bubbles again brings them to the surface; and this action going on uninterruptedly, a motion is set up throughout the whole mass of the liquid characteristic of fermentation. When the process is complete the liquor clears, the sugar has disappeared, and the whole will be found to have acquired intoxicating properties—in other words, the sugar has been converted into alcohol. Neither the true nature of a ferment nor its *modus operandi* is even now thoroughly understood. If examined through a microscope yeast will be found to consist of a number of minute globules, or cells as they are termed, which actually grow or germinate during the action of fermentation; so that the term yeast-plant is often used, although there is some doubt as to whether the globules do not partake rather of the nature of animal than plant life. This microscopic fungus, if we may so term it, appears to grow at the expense of the sugar, giving out carbonic acid and generating alcohol. Whether yeast is the cause or the effect, or simply an accompaniment of fermentation, has long been a disputed point, and it has not been positively decided that its presence is necessary for the commencement of the process of vinous fermentation; but the great weight of opinion certainly leans towards the affirmative.

The nature of a ferment reconsidered.

Albumin in vegetable juices.

Action set up in fermentation.

Results of this action.

Organic nature of yeast and other ferments.

Growth of yeast plant.

XII.

Rotation—Moments.

§ 53. In considering the question of rotation, it will be desirable to make use of an easily constructed piece of mechanism, which will serve to give distinctness to our ideas upon the subject. Even to those readers who have not the opportunity of making the apparatus, the description will not be without use; but the time spent in putting together the mechanism we are about to describe will assuredly not be wasted. The body whose motion is to be investigated is a ball or globe mounted on an axle which passes through its centre. A small terrestrial globe, which has ceased to be utilized geographically, will do very well for the purpose. The globe is

Apparatus.

to be mounted in a circular ring, provided with sockets for the reception of the ends of the axle of the globe. The brass "meridian," with which most terrestrial globes are furnished, is just the thing, except in one respect that does not concern us yet. If now the ring be fixed, the globe is a body in which two points are fixed—namely, the ends of the axis: or we may put it in another way by saying that a straight line in the globe is fixed—namely, the axis. Under these circumstances the globe is capable of turning in either of two opposite directions, and cannot move in any other way. Such motion is in many respects like the straight-line motion we have already discussed. It may take place backwards or forwards; it may have any velocity, uniform or variable; it may have any acceleration; and the mode of measuring velocity and acceleration are precisely analogous to those employed in the case of straight movements.

Everything else remaining the same, let one point of the globe (not in the axis) be fixed. This may be done, for instance, by pressing with a finger on any point on the surface except the poles or ends of the axis. While this is done the globe cannot move at all; and we learn that *if three points of a body be at rest the whole body is at rest, provided the three points are not in the same straight line.* From the former part of this paragraph we learn that *if two points of a body be at rest the whole body may be turning round the axis joining those points, but cannot move in any other way.* It still remains to find out how a body may move when only *one point* is fixed, and for this purpose we must add to the apparatus already used.

§ 54. For our present object the "meridian" ring of the globe is incomplete in one respect. It must be provided with an axle. But as this would interfere with the motion of the globe if it extended across the inside of the ring, we will be content with the two ends of the axle projecting a short distance beyond the ring, away from the centre. A larger, but otherwise similar, ring serves as a holder to the smaller ring, just as the latter holds the sphere. The outer ring itself is supported in any convenient frame in such a way that it is capable of turning on its axle. The axle-ends of each ring should be just midway between the sockets. The whole apparatus is shown in one of its positions by the sketch in fig. 28. It may be noted that the rings can be made of wire twisted together. The ends will serve for the axle-ends; but for smooth working these twisted ends should be fitted into short covers, such as bits of glass tubing, quill, or the like. The sockets may be formed by somewhat larger tubes, properly secured in the right places in the rings. The more massive the rings are the better and more steadily the apparatus will work. We have now got a body of which one point is fixed. It will in fact be evident that the centre of the sphere always keeps the same position. In other respects the globe is unrestrained. If we bring the machine to the position shown in fig. 28, we see that there are three distinct rotations that can occur. The sphere may rotate about its own axis, the rings being at rest. Or the inner ring may be made to spin upon its axis, carrying the globe with it. This can be done without letting the globe rotate upon its own axis. Thirdly, the outer ring may be made to turn, carrying with it the smaller ring and the globe as if in one piece. Moreover, the rotations may be combined in an infinite number of ways. Let the globe be made to spin round its axle; while it is still turning let the inner ring be set in motion; and finally set the outer ring turning, so that all three motions are going on at once. Observe that every motion is communicated to the sphere, so that it would seem to be moving in a very complicated manner. But it will be found, if the apparatus moves "sweetly," as mechanicians say, that during each experiment there are two points on the globe which *do not move.* It is usually pretty easy to find these points—one of which is exactly opposite to the other—especially if the globe has a pattern of any kind traced upon it. But if you don't succeed, the following method will be useful. Take a camel-hair brush, with some paint in it, and hold it steadily in one position while the globe sweeps under it and is marked as it moves. Care must be taken to avoid checking the rings as they pass, and it may be found easier to spottle the colour or ink from a convenient place outside the range of the rings. It will be found that something like a circle is thus traced out, the centre of which is one of the stationary points. The other is at the other end of the same diameter. It thus appears that the result of combining the three rotations is nothing more or less than a simple rotation about a new axis, the ends of which are the stationary points. Also we may infer that *the motion of a body with one point fixed is always a rotation about an axis passing through the fixed point.* This axis may change its position from moment to moment, and in all probability our rotation-apparatus will illustrate this feature only too well.

Rotation machine.

Experiments.

§ 55. The results just obtained are of very great importance, and at the risk of carrying our readers beyond the stereotyped course we shall briefly notice some points closely connected therewith. The first matter that claims attention is a certain mode of representing rotations, which will be found very similar to the straight-line representation of a velocity (§ 11) or of a force (§ 44). Here, again, we use a straight line—namely, the axis about which the rotation occurs. The length of the line shows the velocity of rotation—say the number of revolutions per second, or in some other convenient period of time. The direction (or as it is sometimes called the "sense") of the line, indicated by an arrowhead, points out in which of the two possible directions (or "senses") the body is revolving. How this is done we shall now explain. *If we look at the rotating body in the "sense" indicated by the arrowhead, the body appears to turn in the same direction as the hands of a watch.* In the case of a watch, for example, the arrowhead will point from the front towards the back of the watch. In the case of the earth, its daily spin may be represented by

Representation of rotations.

a line along the axis, with its arrowhead pointing from the centre towards the north pole. Consider the wheels of a cart which passes from the right to the left of an observer. The line representing the rotation of the wheel will point *towards* the observer. For as he stands the wheels appear to turn the wrong way of the watch, and if he wishes to see them moving clockwise he must get on the opposite side of the cart. An ordinary (right-handed) screw has its rotation axis pointing the same way as the screw advances during its turning. These examples will probably suffice to show how any rotation may be completely represented by a directed line of proper length.

But the most important property of these representative lines is that they can be combined together just in the same way as the velocity-lines or force-lines of which we have previously spoken. We are thus enabled to determine, by merely drawing a figure to scale, the nature of the motion that results from the combination of any number of given rotations occurring at the same time: and it is easy to test this with our rotation apparatus, even though we have no special means of measuring velocities.

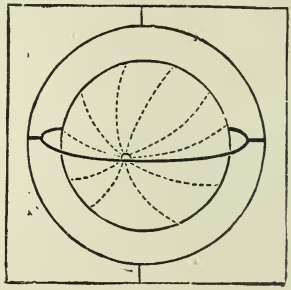


FIG. 28.

Suppose, for example, we make the two rings revolve with about the same speed; the outer ring so that the left hand may move towards the front, the inner ring so that the front may move upwards. Then the first rotation-line is vertically upwards, the second is horizontal towards the left, and they may be represented by A B, B C in fig. 29. The resultant rotation will be given by A C. Interpreting this, we learn that the stationary points will be just under the original position of the outer ring: that one of them will be in the left-hand upper portion, the other being on the right below. As to the sense of the resultant rotation, it is such that if we look down on a higher stationary point the globe appears to turn the wrong way of the watch; for then we look in the direction C A, or opposite to the direction of the rotation axis A C. In a similar manner any combination may be treated. But if we wish three rotations to be combined like those for which the apparatus in fig. 28 is set, the rotation diagram will have to be drawn in perspective. We shall leave it as a trial of the ingenuity of our readers to devise other experiments—such as the combination of rotations about axes oblique to each other, and so on.

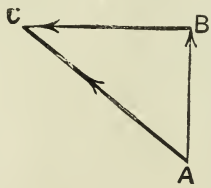


FIG. 29.

§ 56. Before leaving this it may be well to point out the reason for selecting *three* as the number of rotation-axes in the apparatus of fig. 28. If we worked with only two axes there would be an infinite number of motions that could not be obtained by any combination of the two rotations at our disposal. For example, if we were to have the globe clamped to the inner ring, we could never make it move as if it were spinning on its axle and the rings were at rest. For the motion of the outer ring makes one axle-end of the globe move from right to left; the motion of the inner ring makes the same axle-end of the globe move upwards or downwards. Now, it is clear that these two do not counteract each other; so that we cannot, with these two rotations, have the stationary points at the end of the globe-axle. Indeed, as already noted, it will be found that with these two rotations all the stationary points lie under the starting place of the outer ring.

Why three axes.

Now, with three rotation-axes which are not in the same plane—so that they cannot be drawn except in perspective—the case is quite different. We can now produce a rotation about any axis whatever, passing through the fixed point. With the rotation machine already described it is easy to satisfy oneself in this respect. Suppose we wish to make the globe spin so that one of the stationary points shall be about the middle of the front-left-upper region of the globe, and that the globe shall appear to move clockwise as we look down upon this point. The line representing this motion is directed backwards and downwards to the right, as R in fig. 30 (*see* article XIII). The components are the lines marked 1, 2, 3, in the same figure, the last mentioned pointing backwards on the level. The other lines in the figure are merely added with the view of emphasizing the perspective. To get these rotations in our apparatus we spin the globe so that the left side is moving up. This gives rotation "3." The inner ring spins so that the front descends. This gives "2." The outer ring is then made to turn so that the right side moves towards the front. By experiment it will be found that the resultant motion is of the kind desired. If we wish to have the resultant axis in a particular point it will be necessary to have some means of imparting and keeping up *measured* velocities about each axis—a requirement that will seriously complicate the apparatus. But without this it will be easy to convince ourselves of the fact that with three rotation-axes (meeting in a point but not in a plane) we can get rotation about any axis passing through the point. With four, five, or indeed any number of rotation-axes through a point, no more can be done.

Recapitulation.

It will be worth while to put together in this place some of the results we have obtained. We have learnt that a body is at rest—

(1) If three points (not in the same line) are at rest:

(2) If two points are at rest, and there is no rotation about the line joining these points: or

(3) If one point is at rest, and there is no rotation about any one of three axes (not in

the same plane) passing through the point. Also we see that the motion of a body at any moment may be completely represented by two lines; one of which indicates the velocity of any selected point in the body, while the other shows the rotation of the body supposing the selected point to be at rest. We are sorely tempted to enter upon some further developments of this theory, but enough has been said to give the reader a general notion of the subject, and in particular to justify us in confining our further remarks to the motion of bodies with two points fixed.

XL.

Discount (*continued*).

Examples.

N.B.—In the following examples, as we mentioned in the close of our last article, simple interest is charged—not compound. Fractions of a farthing have been generally neglected.

I.—1. Find the present worth of £264 6*s.*, due $2\frac{1}{4}$ years hence, at $4\frac{1}{2}$ per cent. per annum.

2. Find the present worth of £374 5*s.* 10*d.*, due 3 years hence, at 5 per cent. per annum.

3. Find the present worth of £463 5*s.*, due 2 years hence, at $4\frac{1}{2}$ per cent. per annum.

4. Find the present worth of £140 10*s.*, due 9 months hence, at $3\frac{3}{4}$ per cent. per annum.

5. Find the present worth of £302 15*s.* 3*d.*, due 3 years hence, at $4\frac{3}{5}$ per cent. per annum.

6. Find the present worth of £281 4*s.* 2*d.*, due $15\frac{1}{2}$ years hence, at $2\frac{3}{4}$ per cent. per annum.

7. Find the present worth of £2158 4*s.* 10*d.*, due $1\frac{1}{2}$ year hence, at 5 per cent. per annum.

8. Find the present worth of £141 15*s.*, due 1 year hence, at 5 per cent. per annum.

9. Find the present worth of £1353 6*s.* 8*d.*, due $\frac{1}{2}$ year hence, at 3 per cent. per annum.

10. Find the present worth of £230 5*s.*, due 7 months hence, at 4 per cent. per annum.

11. Find the present worth of £1716, due 8 months hence, at $3\frac{3}{4}$ per cent. per annum.

12. Find the present worth of £105, due 4 months hence, at $4\frac{1}{2}$ per cent. per annum.

II.—1. Find the discount on £923 11*s.* 9*d.*, due 3 months hence, at $7\frac{1}{2}$ per cent. per annum.

2. Find the discount on £2100, due 1 year 115 days hence, at $3\frac{1}{2}$ per cent. per annum.

3. Find the discount on £2587 10*s.*, due 55 days hence, at $4\frac{3}{4}$ per cent. per annum.

4. Find the discount on £1506 2*s.*, due 60 days hence, at $6\frac{3}{4}$ per cent. per annum.

5. Find the discount on £24764 8*s.*, due 4 months hence, at $3\frac{3}{4}$ per cent. per annum.

Answers.

I.—1. £240; 2. £325 9*s.* $5\frac{1}{4}$*d.* (nearly); 3. £425; 4. £136 13*s.* $1\frac{1}{2}$*d.* (nearly); 5. £265; 6. £197 3*s.* 4*d.* (nearly); 7. £2007 13*s.* 4*d.*; 8. £135; 9. £1333 6*s.* 8*d*; 10. £225: 11. £1674 2*s.* $11\frac{1}{4}$*d.* (nearly); 12. £103 8*s.* $11\frac{1}{4}$*d.* (nearly).

II.—1. £17 (nearly); 2. £92 8*s.* 1*d.* (nearly); 3. £18 7*s.* 9*d.*; 4. £16 10*s.* 7*d.*; 5. £305 14*s.* 8*d.*

The definitions and explanations of discount we have given so far are applicable to discount properly so called. This discount is sometimes called "*true discount*," to distinguish it from another kind of abatement calculated on a different principle. This latter kind of abatement is generally called discount too, sometimes commercial or mercantile discount, because it is generally used by bankers, bill discounters, and others in mercantile transactions; but it is necessary to distinguish it carefully from the *true* discount which we have treated of hitherto.

Mercantile discount is simply the interest on the sum due, whereas the *true* discount is, as we have seen, the interest on the present worth, and as the present worth is less than the sum due, the true discount must be less than the commercial discount.

For instance, suppose the sum due to be £105, due a year hence at 5 per cent. Clearly the present worth of this sum is £100. The true discount is the interest on this £100, namely £5, but the commercial discount is the interest on £105, namely £5 5*s.* The excess of the mercantile discount over the true discount is evidently the interest on the true discount. Thus, in the example just taken, the mercantile discount is the interest on £105, whereas the true discount is the interest on £100, and the excess of the one over the other is the interest on £5, *i.e.* on the true discount.

We shall now explain the mercantile transactions which generally give rise to discount.

From various circumstances it is often not convenient to pay a debt at once in cash. The debtor in such a case often gives his creditor a *bill of exchange*, which is a written order or request to a third person to pay the creditor, or any one authorized by him to receive it, a certain sum of money at the end of a certain time, named in the order. The following is the usual form of a Bill of Exchange :—

£1000. London,
1*st January*, 1880.

Three months after date pay A B or order £1000 sterling, value received.
Thomas Smith.

To Mr. John Brown,
Birmingham.

This is an order by Thomas Smith to John Brown to pay £1000 to A B 3 months after the day on which it is dated. It is the custom to add 3 days, called "days of grace," to the time at which it is due, so that the above order would not be paid until 3 months and 3 days after the 1st January, *i.e.* until the 4th April. Of course John Brown is not bound to pay this, and probably will not do so

unless he owes the amount to Smith; so A B sends it to him to know if he will undertake to pay it when it becomes due. If Brown undertakes to pay it, he writes the word "accepted" across it and signs his name. Brown is then legally bound to pay £1000 to A B on the 3rd April. The bill is then called an *acceptance.*

The person who makes the order, *i.e.* Thomas Smith, is called the "*Drawer.*" The person who is ordered to pay, namely John Brown, is called the "*Drawee*"; but after he has "accepted" the bill he is called the "*Acceptor.*" A B, the person to whom the money is to be paid, is called the "*Payee.*"

A Promissory Note, or note of hand as it is sometimes called, is a written promise from the debtor to his creditor promising to pay him a certain sum therein stated at a certain time. It is generally in the following form :—

£1000. LONDON,
1*st January*, 1880.

Three months after date I promise to pay A B or order the sum of £1000, value received.

THOMAS SMITH.

This is a promise by Thomas Smith to pay A B, or the person authorized by him to receive it, the sum of £1000. As in the case of a bill of exchange, so here 3 "days of grace" are allowed, and Smith will not be liable to pay anything until the 4th April.

Now suppose that A B wants money at any time before the 4th April, say on the 3rd February : what is he to do? He takes the bill to a banker or bill discounter, or any one who has ready money to spare, and who is satisfied that Smith can and will pay in due time. The banker says, "I can't give you the full £1000, because I should then lose the interest on £1000 during 2 months, but if you allow me to deduct that interest I will pay you the balance at once." Now the banker, instead of deducting the *true* discount, and giving A B the true present worth, simply deducts 2 months' interest on the whole £1000, which, as we have seen, exceeds the true discount. The banker thus gains the difference between the true and the commercial discount, and it is fair enough that he should have something for his trouble and risk. The banker gains in another way, because he generally can borrow the money at a lower rate of interest than that at which the discount is calculated.

In calculating the day on which a bill becomes payable, we must remember to add the 3 days of grace already spoken of. Calendar months are always used. If the day on which a bill is payable, without counting the days of grace, fall upon the 29th, 30th, or 31st, of a month which does not contain so many days, the last day of the month is used instead, and the days of grace then added.

Thus a bill drawn on the 30th October at 4 months becomes due on 3rd March, although February does not contain 30 days.

Example 1.—Find the mercantile discount on a bill for £1000 discounted 3 months before it is due, at 6 per cent. per annum.

Here we have simply to calculate the interest for 3 months on £1000 at 6 per cent.

Interest for a year = £60
∴ „ „ 3 months = £60 ÷ 4 = £15.

Example 2.—What is the discount on a bill for £1015 15*s.* 8*d.*, drawn 8th November at 3 months ; discounted 20th January.

Three months from the 8th November brings us to 8th February. Adding 3 days of grace, the bill is due on 11th February. It is discounted January 20th.

The time it still has to run is 11 days of January and 11 of February—*i.e.* 22 days.

The question is, therefore, what is the interest on £1015 15*s.* 8*d.* for 22 days at 5 per cent.?

The student can work this out for himself. He will find it is £2 1*s.* 2*d.*

Example 3.—A bill is drawn on the 5th June at 2 months. It is discounted 10 days after date at 4½ per cent. What does the holder get for his bill?

It is due on the 8th August (including days of grace), and it is discounted the 15th June.

The time the bill has to run is, therefore,

of June	15	days
„ July	31	„
„ August	8	„
Total	54	„

We have, therefore to calculate the interest on £473 11*s.* for 54 days at 4½ per cent. per annum.

This is found to be £3 3*s.* 1*d.*
The holder receives £473 11*s.* 0*d.*, less £3 3*s.* 1*d.*
£3 3*s.* 1*d.*

Ans. £470 7*s.* 11*d.*

Example 4.—I wish to draw an 8 months' bill on the 4th March, which I intend to get discounted on the 16th June at 5½ per cent. The bill is to be of such an amount that when so discounted on the 16th June I may get £55 15*s.* For what amount must the bill be drawn?

Here the bill is for 8 months, which brings it to 4th November, and, adding 3 days of grace, the bill is due 7th November. It is discounted June 16th. The time it will have to run will, therefore, be

of June	14	days
„ July	31	„
„ August	31	„
„ September	30	„
„ October	31	„
„ November	7	„
Total	144	„

The question is, therefore, the following :

What will be the amount of £55 15*s.* in 144 days at 5½ per cent. per annum?

The amount will be found to be £56 19*s.* 9*d.*

(nearly). The bill must, therefore, be for this amount.

Example 5.—A bill for £1487 is drawn on October 29th at 4 months. It is discounted on December 6th. The discount amounts to £15 19*s.* What must have been the rate of discount?

Here, not counting the days of grace, the bill falls due on the 29th February. But, unless it is leap year, there is no such day. We take the last day of February instead, and then, adding on the 3 days of grace, the bill is legally due on March 3rd.

It is discounted December 6th. The time remaining is, therefore,

of December	25	days
„ January	31	„
„ February	28	„
„ March	3	„
Total	87	„

The question is, therefore, equivalent to the following:

If the interest on £1487 for 87 days amount to £15 19*s.*, what is the rate of interest per cent. per annum?

This is a question in simple interest similar to some we have already considered. The rate will be found to be 4½ per cent.

Example 6.—A bill for £57 18*s.* 10*d.*, drawn February 20th at 5 months, is discounted on a certain day, the holder receiving £57 11*s.* On what day must it have been discounted?

Here the holder receives £57 11*s.* for a bill of £57 18*s.* 10*d.*

∴ the discount = 7*s.* 10*d.*

The question is, In what time will £57 18*s.* 10*d.* produce 7*s.* 10*d.* interest at 6½ per cent. per annum?

The answer will be found to be 38 days. Therefore the bill was discounted 38 days before it was legally due—*i.e.* before July 23rd.

Hence it must have been paid on June 15th.

XL.

The Syntax of the Accusative Case.

Observe as a general rule the accusative case is governed either by a transitive verb or preposition, as *amo puerum*, I love the boy; *ad me venit*, he comes to me. The accusative case often marks the duration of time and extent of space, as (1) *quædam bestiolæ unum diem vivunt*, some little beasts live during *one* day. Here observe that *unum diem* is the accusative of duration of time (time how long) governed by *per*, during, understood, not by the verb, which is not a transitive verb governing an accusative case. So in (2) *agger erat pedes triginta latus*, the mound was thirty feet broa (*i.e.* was broad-*over*, extending over thirty feet), *per* being understood to govern *pedes* in the accusative case. *Natus* is often used in this way to denote age, as in *puer decem annos natus*, a boy ten years old—that is, *ten years extending over* the time from his birth.

The accusative is often used of *closer definition*, especially by the poets, after verbs, participles, adjectives, to mark the part specially referred to—as in *equus artus tremit*, the horse trembles in his joints. Here observe that *artus* (accusative) is not governed by the verb, which is intransitive, and as such cannot under any circumstance govern an accusative case, but simply defines closely the action of the verb, and tells us where the trembling takes place—in the *limbs*. (Some call this the Greek accusative of relation, which is governed in Greek by κατά, as to, understood.)

The neuters of some pronouns—such as *hoc*, *id*, *illum*, *idem*, etc.—and of adjectives implying number—as *unum*, *multa*, *pauca*—are frequently used as a sort of cognate accusative with a verb, as in *idem gloriari*, to boast the same (boast); *discipulus id unum moneo*, I admonish the pupil of that one (thing). The accusative is also used *adverbially* in such expressions as *magnam partem*, *maximam partem*, for the most part, for a considerable degree; *vicem*, on account of; *cetera*, in all other respects, as *vir cetera egregius, et maximam partem nobilis*, a man illustrious in all other things, and for the most part noble.

The accusative is used in exclamations, either with or without an interjection, as in *en quatuor aras*, behold, four altars! and in *me cæcum*, blind man that I am, not to have seen these things before! Here *aras* and *me cæcum* are accusatives of exclamation.

The accusative of direction is where a local noun is placed in the accusative *without a preposition* to mark the direction of the verb, as *Italiam venit*, he came to Italy. It is in this way we are to understand the accusatives *domum*, towards home; *rus*, towards the country; or such sentences as (1) *Ego rus ibo, et ibi manebo*, I will go into the country, and there will I remain; (2) *Semel egressi, nunquam domum revertere*, having once gone forth, they never returned home.

Exercises.

Translate into English the following passages from Latin authors:—

Pericles quadraginta annos rempublicam administravit. Erant muri Babylonis ducenos pedes alti. Aram latam decem pedes facito. Iter unius diei aberat. Triduum ibi manebat. Tria millia passuum progressus erat. Murus viginti pedes altus erat. Num ibi biennium mansisti? Templum iter multorum dierum inde aberat. Navis duodeviginti pedes lata erat. Biduum ibi manebimus. Ne ibi diutius quam sex dies moratus sis. Num ibi biduum an triduum manserat? Turres confecerant quinquaginta pedes altas. Multos annos vixit. Tuam vicem sæpe doleo. Homines quidam maximam partem lacte atque pecore vivunt. Curius primus elephantes quatuor Romam

duxit. Pausaniam cum classe communi Cyprum atque Hellespontum miserunt. Rus redeo, nec domum iterum ibo. Heros vulneratus est et pedes trajectus est. Suspensi loculos (*satchels*) tabulamque lacerto pueri ibant ad ludum (*school*). Alcibiades annos circiter quadraginta natus diem obiit supremum. O vim maximam humani erroris! Pro deorum atque hominum fidem! Fœminæ nuda brachia atque lacertos saltabant.

Translate into Latin :—

What consul administered the republic for forty years with great success? The river Nile overflows the banks all the summer. The bears sleep in their dens all the winter. He lived all his boyhood near to that city. Near Rome the snow lay deep many feet. He built a wall two hundred feet high and five feet broad. He was remaining in that city for two years (*biennium*). For ten whole days he continued walking about the city. For how many years did he live? The Greeks besieged Troy for ten years. The enemies were for two months trying to cross the great and rapid river before them. These towers were built thirty feet high. I love to go to the country, and also to return (to) home. Hannibal fell severely wounded in his right foot. O foolish and blind minds of men! He is twenty years old. He makes the same boast to every one. The king governed the state for fifty and five years and two months. The games were celebrated by rich and poor for three whole months. The horse feels a pain in its head, and trembles in its legs. The ten men fought for ten hours. He leads his army to the city Rome. They remained true to their country all their lives.

Self-Examination Questions.

What is the general rule about the government of the accusative case? Give an instance of the verb and an instance of the preposition governing the accusative. What is meant by the accusative of closer definition, or the Greek accusative? Give examples. What is meant by the accusative of direction, and the accusative of exclamation? Give examples of each. Explain the usage of *rus* and *domum*.

XXXVI.

GREECE (*continued*).—THE PERSIAN WARS, B.C. 500-478.

WE have now reached the period in which Greece was to undergo the first of many attacks from her great neighbours—in which she was to suffer much, sometimes winning immortal glory by acts of unsurpassable heroism, and unfortunately not unseldom covering herself with the shame of treachery and disunion. It is satisfactory to find that of all the Greek states Athens—the most advanced in democratic principles—offered the most determined and unwavering resistance to invasion, and deserves the chief credit of having saved Europe from the Persians.

Persia and the Greek colonies.

To show how the Persians came to invade Greece we must go back a little. We have seen that there were many Greek colonies, chiefly of Ionic Greeks, settled on the coast of Asia Minor and in the islands of the sea between Greece and Asia Minor. These colonies became very rich, and had powerful navies. But they had no inland territory. Their inland neighbours were the Lydians, whose kings could not long resist the temptation of conquering such rich cities. They, however, treated the colonies very well after conquering them, and the colonies having great maritime power were able to make good terms for themselves. Crœsus was the king of Lydia who finally reduced them all to submission, on condition that they were to manage their own affairs and merely pay him a yearly tribute. But Crœsus himself was not long afterwards taken prisoner and deposed by Cyrus, the leader of a hardy and warlike mountain nation called Persians, who having lately conquered their kinsmen the Medes, now overran Lydia. The Ionic cities offered to submit to Cyrus on the same terms that they had submitted to Crœsus. Their offer was rejected and harder conditions proposed to them. They decided to fight, and were accordingly besieged one after another, and being without any kind of union for mutual self-defence, fell an easy prey to their new and terrible enemies, whose methods of warfare were strange to them. They did not all ignominiously submit. Many of them, rather than do that, sailed away in their ships, taking with them what scanty remnants of their ancient wealth they could, and after wandering over many seas settled at last, some in south Italy some in Thrace. The coast of Asia Minor, with its valuable naval ports, in this way fell into the hands of the Persians. Many of the islands followed the example of the colonies, and soon Phœnicia also submitted; so that the Persians now had amongst their vassals the two greatest maritime countries of the time.

Crœsus.

Cyrus.

Persia becomes a naval power.

Cyrus was succeeded by his son Cambyses, who in his short reign of three years added Egypt and Cyprus to the Persian dominions. Darius was the next king of Persia, and his first care was to regulate the internal affairs of his empire. He divided his dominions into large districts which he called satrapies, presided over by a satrap or viceroy. Such a satrapy often included a whole conquered nation, such as Egypt. He also made great roads, such as the Romans used long afterwards to make, from his capital Susa to all parts of the empire.

Darius.

Unfortunately his own ambition, or the warlike restlessness of his people, induced him, in an evil hour for himself, to attempt to enlarge his dominions at the expense of his European neighbours. An expedition was planned against

the Scythians, who dwelt in that part of what is now Russia between the Danube and the Don. An immense army and a fleet of 600 ships assembled on the Bosphorus, which the army crossed by a bridge of boats, probably not far from the spot where Constantinople now stands. This was the first appearance of the Persians in Europe (B.C. 510). The expedition was a failure. The Scythians kept out of reach of the Persian army, who after suffering great hardships and losing great numbers by sickness, were compelled to retrace their steps. But they left a considerable force, said to have been 80,000 strong, to subdue the country north of Greece. This conquest materially helped the Persians in their attack on the Athenians a little later.

Persians enter Europe.

About ten years after Darius' first incursion into Europe, the Ionic cities were persuaded by Aristagoras, the Tyrant of one of these cities, to throw off the Persian yoke. They revolted accordingly, and Aristagoras came to Greece to try to persuade the Greeks to help their colonies. Sparta, with that selfishness which characterized all her foreign policy, would send no help. But Athens sent twenty ships, and another small state, Eretria, sent five. The allies marched suddenly on Sardis—the ancient Lydian capital, and at that time an important Persian stronghold, —took it by surprise and burnt it, but not having a sufficient force to hold it, had to retire again to the coast, and the Athenians sailed home, leaving the colonies to defend themselves as best they could. These fought long and in some cases with desperate valour; but after about four years the Persians defeated the colonies in a great naval battle—thanks, in great measure, to the treachery of some of the islands—and captured all the cities, slaying the men and carrying off the women and children into slavery.

The colonies revolt.

Burning of Sardis by Athenians.

Victorious over the colonies, the Persians now had leisure to think of vengeance against the Athenians, who had had the audacity to attack and burn a great Persian city. The first expedition for this purpose was sent off under the Persian general Mardonius, in B.C. 493. Crossing into Europe over the Hellespont, they marched along the coast westwards towards Greece. Their fleet kept pace with them. But a great storm arose and wrecked 300 of their ships, and sent some 20,000 of their troops to the bottom of the Ægean sea. Disheartened by this great loss, and harried by the wild tribes through whose country they were passing, Mardonius turned about and made his way back in disgrace to Asia.

First Persian expedition against Greece, B.C. 493.

COSTUMES AND ARMS OF ANCIENT GREECE.

But Darius was determined not to be baulked of his vengeance so easily. So three years later (B.C. 490) he sent a second expedition, intended to utterly crush the audacious little Greek states. They had indeed treated him, the mighty ruler of half Asia, with intolerable insolence; for when his ambassador arrived demanding earth and water in token of submission, the Athenians threw him into a pit, and the Spartans ducked him in a well.

Second Persian expedition against Greece, B.C. 490.

Darius ordered his generals to burn to the ground Athens and Eretria—the two cities

which had joined in burning Sardis—and to bring the inhabitants in chains to him. But this expedition was destined to fail more ignominiously than the former, as we shall see. They did indeed succeed against the insignificant little state of Eretria, aided by traitors within who were bought with Persian gold. And now at last they were almost within sight of the great object of their vengeance—Athens. They landed on the ever-memorable plain of Marathon (B.C. 490), about twenty miles from Athens, in number probably exceeding 100,000 men. The Athenians could only muster 9000. Sparta had sent no help as yet. Athens stood alone, facing the overwhelming force of Persians, who had never yet met their equals in the field since first they set out on their career of conquest under Cyrus, overturning with irresistible force the ancient and powerful empires of Media, Lydia, Babylon, and Egypt, as well as the Greek colonies, some of which were supposed to be at least as powerful as Athens. It was a moment of extreme peril, not only for Athens but for all Greece; yet Greece stirred not. But now occurred one of those touching and beautiful incidents which happily are not unfrequent in Greek history. The little state of Platæa had lately been helped out of some troubles by her powerful neighbour Athens, and now in the desperate extremity of her benefactress Platæa determined to share her fate. The whole fighting population of this diminutive state turned out, and marched to join the Athenian army. It was only 1000 men, but the moral effect upon the Athenians and the enthusiasm with which it inspired them were of priceless value. Fickle as the Athenians were, they never forgot this act of devotion, and to the latest times showed their gratitude to the descendants of this heroic little band.

Marathon.

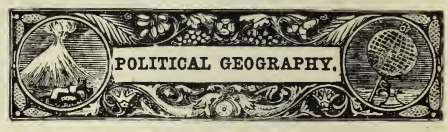
The Greek force was now 10,000 men—less than one Greek to every ten of the Persians facing them on the plain of Marathon. The ten Athenian generals held a council of war. Five of them were for waiting till the promised Spartan troops should arrive. But the other five, headed by Miltiades, a man of great experience, who had formerly been a Tyrant, urged immediate action, and his views ultimately prevailed. The other generals agreed to let him have supreme command. Having made his arrangements, and the generals having addressed the troops, the Greeks charged in three divisions. The two side divisions or wings of the Greeks drove their opponents before them, who were astonished by the suddenness of the attack. The centre of the Greeks was repulsed, and for a moment was in danger of annihilation; but the wings rallying to their aid routed the Persian centre, who fled to their ships, great numbers being drowned in the sea and killed by the pursuing Greeks. It is said that 6000 Persians fell, and only 192 Greeks. But notwithstanding this victory Athens narrowly escaped being taken; for while the battle was going on traitors in the city made signals to the enemy that the city was without troops, and the Persians embarking in their fleet sailed down the coast, hoping to surprise Athens, which lay only four miles inland. Fortunately the signals were seen by the Greeks also, and suspecting treachery, Miltiades marched with the army straight back to Athens; and when the Persians saw their late victors ready and waiting for them they sailed away without attempting anything further, and returned to Asia.

To Athens and Platæa, and to Miltiades their leader, belong the glory of this important victory, which is justly placed among "the fifteen decisive battles of the world." Its importance can hardly be over-estimated, for had the Persians been victorious all Greece would inevitably have become a conquered province of the Persian empire, ruled over by a Persian governor, and the national life of Greece would have been crushed out. The principles of free government which they developed and gave to the rest of Europe would never have been acted upon, and possibly the Persian arms and despotic government might have overspread all Europe and changed its history into something resembling that of Asiatic countries, where the sovereign is a despot and the people little better than slaves.

Consequences of Marathon.

Miltiades was loaded with honours, and the fullest confidence was reposed in him by the Athenians. It is sad to have to record that he abused this confidence to gratify private feelings. Nothing but his great services at Marathon saved him from being condemned to death, which according to the laws of Athens he deserved; and he died soon afterwards in poverty and disgrace not unmerited.

End of Miltiades.



VI.

RUSSIA.

THIS extensive empire comprises about three-fifths of the continent of Europe, and about one-third of that of Asia, or nearly one-sixth of the territorial surface of the globe. It is almost as extensive as the territory under British rule, but in proportion to its extent its population is but small. It has in all an area of 8,325,000 square miles (2,075,000 in Europe and 6,250,000 in Asia), and (in 1877) 86,952,000 inhabitants (76,624,000 in Europe and 10,328,000 in Asia).

Russia in Europe is situated between lat. 40° 20′ and 70° N., and long. 17° 50′ and 67° E.; and is bounded on the north by the Arctic Ocean and Norway, west by Sweden, the Baltic, Prussia, Austria, and Roumania, south by the Black Sea and Mount Caucasus, and east by the Caspian Sea and Siberia. Its length from north to south is 1700 miles, and its greatest breadth from east to west 1500. The Ural mountains, which form its boundary on the east, separating it from Asia, extend through

eighteen degrees of latitude, and are of great breadth, but of no great elevation, averaging only about 1000 feet, while their loftiest summit does not exceed 5,400. The range of Mount Caucasus, which bounds it on the south, extends in a W.N.W. and E.S.E. direction between the Black Sea and the Caspian, and is about 700 miles in length by from 65 to 150 in breadth, and has as its highest point Mount Elburz, 18,500 feet high. The whole of the interior of Russia is an immense plain of slight elevation, the only exception being the Valdai hills, in the government of Novgorod, the highest part of which does not exceed 1100 feet. A great portion of the surface, especially in the south-east, is occupied by immense deserts called *steppes*, either destitute of vegetation or scantily covered with grass, and here and there a stunted tree. The vast region of the *tundras*, in the north, beyond lat. 64° N., is a swamp in summer and is covered with ice for nine months in the year. In the centre of the country are extensive forests of pine, fir and birch in the north, and oak, elm, lime, etc., in the south. Russia is watered by numerous rivers, some of them being the largest in Europe. The principal are the Ural, Volga, Kouma, and Terek, falling into the Caspian; the Don into the Sea of Azoph; the Kouban, Dnieper, Bug, and Dniester, into the Black Sea; the Vistula, Niemen, Narva, Neva, Ulea, Kemi, and Tornea, into the Baltic; and the Onega, Dwina, Mezen, and Petchora, into the White Sea and Arctic Ocean. There are a large number of fresh and salt water lakes, chiefly in the north and north-west, the largest being Lakes Ladoga and Onega, the former having an area of 6200, and the latter of 3500 square miles.

From its vast extent Russia possesses a great variety of climate, and owing to its eastward position it is much colder than any other European country within the same latitudes. St. Petersburg, in lat. 59° 56′ N., has a mean annual temperature of 39°, being in summer 61° and in winter 18°. In July it sometimes rises to 90°, and in January sinks as low as 22° below zero. In the north the climate is much more severe, and in the south proportionally milder. In general it is highly conducive to health, and individuals frequently attain a very great age. The vegetable productions are very various. Barley, oats, and rye, are the principal crops in the north, while in the centre and south wheat is raised in great abundance and forms an important article of export. Hemp and flax are extensively cultivated, and in the south maize and tobacco are grown. In the central provinces apples, pears, plums, and cherries, are common; and in the southern, grapes, peaches, figs, melons, almonds, pomegranates are cultivated. The forests furnish excellent timber, which is largely exported by way of the Baltic and Archangel, as well as tar, pitch, and potash. There are great numbers of horses, cattle, sheep, swine, and goats in the country; and among the wild animals are the bear, wild boar, fox, wolf, etc. The reindeer is common in the north and the camel in the south. The seas and rivers abound in fish.

The mineral wealth of Russia is great, centring chiefly in the Ural region, where gold, silver, copper, iron, lead, and platinum are largely obtained. Iron is also found in the southern provinces and in Finland. Coal is obtained in the south and in some other parts, but nowhere in great quantity. Rock salt is found in various parts, and brine springs occur in the south. Manufacturing industry has made considerable progress in Russia of late years, but it is still not in a very active or flourishing condition. It is mostly in the hands of the peasants, who take to it during the long winters; and except in the neigbourhood of the larger towns, as St. Petersburg and Moscow, few of the establishments are of large size. The principal manufactures are woollen, linen, cotton, and silk stuffs, cordage, sailcloth, metallic goods, leather, tallow, soap, and beet-root sugar. Russian leather is famous, and largely used in bookbinding. At St. Petersburg, glass, porcelain, jewellery, etc., are manufactured. The principal trading ports of Russia are Archangel, on the White Sea; Riga, Cronstadt, and St. Petersburg, on the Baltic; Odessa on the Black Sea; and Astrakhan on the Caspian. The chief exports are tallow, hides, timber, corn, flax, hemp, cattle, oil, and metals; the imports, cotton, wine, silk, rice, sugar, tea, coffee, dyes, machinery. In 1879 the total exports were £123,000,000, imports £112,000,000. Great Britain took £36,872,000 of the exports, and sent £29,312,000 of the imports. The internal trade of Russia is chiefly carried on by fairs held periodically in different parts of the empire, the principal of which is that of Nijni Novgorod, at the confluence of the Volga and Oka, which lasts for a month or six weeks, and attracts strangers from all parts to the number of about 200,000. The trade of Russia is much facilitated by its numerous navigable rivers and vast system of canals, by means of which the White Sea and the Baltic have direct communication with the Black Sea and the Caspian.

The government is an absolute monarchy exercised by the Czar or emperor, who is also the head of the church. Under him are four great councils—the Imperial Council, Directing Senate, Holy Synod, and Council of Ministers, by which the affairs of the state are conducted. The court and the great body of the people belong to the Russo-Greek church, but toleration is extended to all religious sects. In the Polish provinces a great part of the people are Roman Catholics, and Protestantism is generally professed in the Baltic provinces. In the south-east many of the inhabitants are Mohammedans, and even pagans. Serfdom was abolished in 1863. About four-fifths of the population are Slavs—of whom are the Great and Little Russians, the Poles, Letts, and Lithuanians. The first are much the most numerous. The principal of the other races are the Finns, Tatars, and Kalmucks. There are about 2,000,000 of Jews, chiefly in Poland and the south-west provinces. In 1879 the total revenue was £132,390,000, the expenditure £128,384,990, and the public debt £896,000,000. The effective regular army on the peace footing numbers 840,711 men, capable of being raised

in time of war to 2,264.293. The navy comprises in all 389 vessels of 243,866 tons, carrying 836 guns and manned by 26,153 men. Russia is divided into sixty governments; and the chief towns are St. Petersburg and Moscow, with 667,963 and 601,969 inhabitants respectively.

The empire (excepting Finland) is divided for educational purposes into ten circles, each of which is under the superintendence of a curator. There are eight universities: at St. Petersburg, Moscow, Dorpat, Kiev, Warsaw, Kazan, Khar, Kov, and Odessa. Finland has a university of its own, at Helsingfors. Dorpat is the only one which has a theological faculty. The number of professors at the eight universities in 1873 was 545; of students 6,697. The number of lyceums and gymnasiums was 126, and of pro-gymnasiums 32; the aggregate attendance of these institutions was 42,791. According to the report of the minister of public instruction in 1872 the number of popular schools was 19,658, with 761,129 pupils, of whom 625,784 were boys and 135,345 girls.

"The mass of the population of Russia," says Mr. Frederick Martin, "is as yet without education. In 1860 only two out of every hundred recruits levied for the army were able to read and write; but this proportion had increased in 1870 to eleven out of every hundred. In the Grand-Duchy of Finland, which has a system of public instruction separate from that of the rest of the empire, education is all but universal, the whole of the inhabitants being able at least to read, if not to write."

VIEW IN MOSCOW.

THE MEDICAL PROFESSION.

ONE of the first events that sobers the boy, that brings him full in view of the yet distant hill top of adult manhood, is the decision of the question "What are you going to be?" Our present object, however, is not to answer this question for our readers, each of whom must ultimately answer it for himself. All we mean to try in the course of this short article is to give such information regarding the medical profession that they shall have the grounds for a rational decision regarding it, and should they choose it as their future life-work enable them to steer clear of certain mistakes at the outset.

We must preface our remarks by saying that they must necessarily be of a very fragmentary character; but we console ourselves by the thought that most, if not all of our readers who have thought of entering the medical profession, will have a medical friend, or a family medical man, to whom they can refer for advice on points of detail that we may have omitted. The fact that advice is often sorely needed has over and over again been made very patent to us by cases of lamentable and more or less irremediable mistakes committed by parents or guardians, or by students of medicine themselves, in arranging their course of study.

Certain preliminary points come up for consideration before the main issue; these are such as age, health, preliminary education, and money outlay. With regard to age, each case is of course a law unto itself—that is to say, boys and men differ so much in their growth and capacity for growth at different ages that no general law can be laid down. Still we should say that it will as a general rule be a mistake to commence the study of medicine before the age of seventeen or after the age of twenty-five. The minimum preliminary education cannot be acquired much earlier than seventeen, nor previous to that age has the character as a rule the maturity requisite for such a study. On the other hand, to put off the study of medicine later than twenty-five is to risk a laborious acquirement, and what is much worse, a fruitless possession of its truths. At the age of thirty, the great bulk of men, while they manipulate to greater purpose truths with which they have for some time been familiar, already begin to feel some diminution in the plasticity of mind required for the acquisition of fresh habits of hand and eye, for the digestion and assimilation of fresh truths. Still this loss may in some cases be more than compensated by the increased power of concentration, the greater sobriety and fixity of purpose, and above all by that deeper insight into the realities of life which tends to render all study more true and earnest. The question of health is simpler than that of age. For the future medical man the *mens sana in corpore sano* is indispensable. His undergraduate career will make no small demands on his physical and his mental vigour, and in no calling are mind and body exposed to more sudden and violent strains than in the medical profession. Those who are "of weaker capacity," either physically or mentally, ought to turn their attention in some other direction.

Age and health being satisfactory, the first point in the prospective medical man's career is registration by the General Medical Council as a student of medicine. Until this has taken place, no attendance on lectures, no experience in practical work, will count. The Medical Council has wisely required of all candidates, that previous to registration they shall have passed a preliminary examination in certain branches of general education, namely:—1. English language, including grammar and composition; 2. English history; 3. Modern geography; 4. Latin, including translation from the original and grammar; 5. Elements of mathematics, comprising—(*α*) arithmetic, including vulgar and decimal fractions, (*β*) algebra, including simple equations, (*γ*) geometry, including the first two books of Euclid or the subjects thereof; 6. Elementary mechanics of solids and fluids, comprising—the elements of statics, dynamics, and hydrostatics; 7. One of the following optional subjects—(*α*) Greek, (*β*) French, (*γ*) German, (*δ*) Italian, (*ε*) any other modern language, (*η*) logic, (*ζ*) botany, (*θ*) elementary chemistry. Now, it is here that the first mistake is generally committed. Some one preliminary examination is passed of the many recognised by the General Medical Council, our protégé is formally registered as a student of medicine, and has studied for two years, we shall say, when it occurs to him—perhaps after he is safe through the primary examination of the College of Surgeons of England—that he would like to graduate at a university, to take a diploma, say that of the University of London. The preliminary examination, however, which he has passed is not recognised by the University of London, which requires you to pass its own matriculation examination and its own preliminary scientific examination. Many a time we have been sorry to see a man who has made some such mistake as this striving to rectify it by working hard at Greek and mathematics in the middle of his professional work; but the attempt is successful only in very rare cases, and even then the success is dearly bought at the expense of professional studies neglected or crammed and undigested. Our advice to all intending students is to consider carefully whether they would not wish to take the degree of a university in place of, or in addition to, the licence of a corporation. If so, they ought next to consider at what university they would wish to graduate, and then if possible let them take the degree in Arts of that university, or at least let them take its preliminary examination as well as any further examination in general knowledge required for its higher degrees. A degree in Arts stamps an educated man, and ought to be taken by every intending student of medicine if it is at all possible.

The cost of a medical education varies much according to the school chosen, and therefore we must here say a word upon that head. The choice will very often be decided by convenience—nearness, for example, or the fact that relatives live near the school. In asking advice it is to be remembered that as a general rule each medical man thinks his own school the best. He probably knows little or nothing of any other school—in a detailed or practical way at least. Cheap schools are not by any means always bad, nor on the other hand are expensive schools necessarily good. Ascertain rather whether the school you contemplate deciding upon is a working school with good traditions, whether a full share of attention is given to the work of the first year, and lastly whether the teachers are energetic, good disciplinarians, as well as able men. The fees in London schools are paid either in one sum at the commencement of study, or in instalments. We subjoin the total fees for lectures and hospital practice at the following schools:—St. Bartholomew's, £138 12*s.*; Charing Cross, £91 7*s.*; St. George's, £125; Guy's, £131 5*s.*; King's College, £125; London Hospital and Medical College, £94 10*s.*; St. Mary's, payable in instalments according to arrangement; Middlesex, £90; St. Thomas's, £125; University College, £131 5*s.*; Westminster, £100. The fee for the membership of the College of Surgeons of England is £22; for the Licence of the College of Physicians of England £15 15*s.* In the Scotch and Irish schools the fees are paid for each class separately. At Edinburgh University the total minimum expenses for the degrees

of Bachelor of Medicine and Master in Surgery, including graduation fees, amount to £107 18*s*.

The course of study in all schools extends nominally over four years, and in the Scotch Universities this is rigidly enforced; but in England three winter sessions and two summer sessions is considered sufficient, leaving an extra winter which may be spent in practice under certain restrictions. The first part of the curriculum consists largely of the preliminary sciences, botany, chemistry, and zoology; and candidates are strongly recommended to take at this time as soon as possible the preliminary scientific examination of the University of London, should they intend graduating there. The examination is a testing one, including inorganic chemistry, experimental physics, botany, and zoology.

Here let us interrupt our remarks to say a word to parents and guardians. In nine cases out of ten when a medical student goes to the bad, it is during the first year of his curriculum. Coming perhaps from a country home, he is thrown suddenly into all the temptations of town life. A youth should never be sent to live in lodgings if it can be avoided, but ought to be boarded in a family during his first and perhaps also his second year. He has frequently no examination at the end of his first winter, and two years seem a long time at his age. Accordingly he falls into idle habits, finding in all probability many congenial associates therein. Let it therefore be regarded as a bounden duty by all parents and guardians to ascertain whether they are working or idling during their first session, and if possible also to see that they have an examination to pass at the end of their first winter or second summer session.

There are in Great Britain nineteen bodies whose licence or diploma qualify a man for registration as a medical practitioner. The value of these various qualifications, as may readily be supposed, is very various, and the amount of study required is as various. We cannot of course give an account of the regulations of these various bodies, but we shall refer to a few of them, remarking at the outset that every student ought to make his course as comprehensive as possible, lest at some future time he should wish to take a higher diploma than that he originally contemplated.

By far the most important qualification in England is the membership of the College of Surgeons of England, which is taken by almost all English practitioners and by some Scotch and Irish. The examinations for it are two —the primary and the pass. The primary examination, on anatomy and physiology, is partly written and partly demonstrative on the recently dissected subject, and on prepared parts of the human body. The pass examination, on surgical anatomy and the principles and practice of surgery and medicine, is partly written, partly oral, and partly on the practical use of surgical apparatus and the practical examination of patients. These examinations are held four times yearly, and are usually taken at the close of the second and fourth years of study.

The licence of the College of Physicians of London involves three professional examinations. The first is on chemistry and chemical physics, materia medica, medical botany and pharmacy, osteology ; the second is on anatomy and physiology ; and the third on medical anatomy and pathology, and the principles and practice of medicine, surgical anatomy and pathology, and the principles and practice of surgery ; midwifery, and diseases of women. Forensic medicine, public health, and therapeutics are also included, Besides these two, various other corporations in England, Scotland and Ireland, grant licences to practise.

The University of London differs widely in its requirements from all other bodies, as we have already indicated. Its degree of M.B. involves two professional examinations, in addition to the matriculation and preliminary scientific examinations already mentioned. It is to be noted that the University of London differs from other universities in being a purely examining body, requiring no residence, like the nine months' residence of Durham and the two years' residence of the Scotch universities. Its degrees hold a high place, and are proportionately difficult to obtain.

The regulations of the three Scotch universities of Edinburgh, Glasgow, and Aberdeen, are in all but the smallest details identical. The course required extends over four years, one at least of which *anni medici* must be spent at the university where graduation is to take place, and another either at that university or in some other university entitled to give the degree of Doctor of Medicine. The professional examinations for the degrees of Bachelor of Medicine and Master in Surgery are three in number, taken at the end of the second, the third, and the fourth winter sessions; but under certain conditions candidates are allowed to pass the preliminary scientific portion of their studies between their first and second winter sessions. Candidates for graduation are required to be twenty-one years of age, and to produce certificates of a full and practical curriculum ; the details of which will be found in the calendars of the various universities. The degree of Master in Surgery is not conferred on any person who does not at the same time obtain the degree of Bachelor of Medicine. The degree of Doctor of Medicine may be conferred on any candidate who has obtained the degree of Bachelor of Medicine, is twenty-four years of age, and has since graduation been two years in active practice. He must also, unless a graduate in Arts, pass a further examination in general education, and send in a thesis on some medical subject composed by himself. The further examination in general education ought of course to be passed at the beginning of medical study, else in the middle of practice it probably never will be passed, and for this trifling obstacle the higher degree will not be taken. Into the regulations of the Scotch corporations of Edinburgh and Glasgow we have not space to enter.

There is really no school of medicine at St. Andrew's, but it is possible to make an *annus medicus* by attendance on certain courses, and

the regulations for graduation are the same as those of the other three universities, with some exceptions. Also this university is by ordinance allowed to confer the degree of M.D. on any registered medical practitioner above the age of forty years, of approved standing and experience, who shall on examination satisfy the medical examiners, the number of such practitioners being limited annually to ten.

The University of Dublin grants degrees and licences in medicine, surgery, and midwifery. For the degree of M.B. the candidate must be a graduate in Arts, and have gone through a medical curriculum of four years. Having passed the previous medical examination in all the subjects, the candidate is admitted to the final or pass examination. The fee is £11.

Let us suppose now that the graduation ceremony is over, or the licence taken, and our young medicus is a full-fledged practitioner: the very serious question then appears of what he is to do with all this laboriously acquired knowledge. Advice on this head will much depend on the circumstances, pecuniary and domestic, of the graduate. If he is a free man, and can afford to wait a year or two before settling down, we should recommend him to spend a year in some resident appointment in a large hospital; or if he has already enjoyed the clinical opportunities of a large field, to spend a year or more in the medical schools of Vienna, Berlin, and Paris. When he comes to settle down we may say he has three alternatives before him: (1) He may settle in private practice at home; (2) He may enter one of the public services; or (3) He may go to the colonies. The public services—that is the Indian Medical, the Army Medical, and the Navy—have their advantages and disadvantages. The life is free, and in time of war has plenty of excitement; but in the main it is monotonous, while also unsettled. The principal disadvantages, however, are—first, promotion is almost wholly by seniority rather than by merit; second, the unsettled life is not conducive to study, so that keeping abreast of medical knowledge is next to impossible; and lastly, home and friends have to be left. The colonies afford good openings for men without ties and of an energetic disposition, not afraid to rough it for a time, and able to turn their hand to other work besides medicine. There is room, however, for good men at home. Genius is no doubt requisite for great success, but steady perseverance and conscientious work will bring a meed of success to each. General practice, either in town or country, must be the work of the majority, and no branch of medical work is more honourable or affords better opportunities for the exercise of the highest qualities of heart and mind. The tendency now is, even in England, to leave the dispensing of medicines to the apothecary; and the sooner this is done entirely, the better for all concerned. In the large cities there always will be a larger or smaller class of men, more or less separated off as consultants—a high if a difficult position to hold, which can be attained only by the few, and that often as much from social advantages as from inherent preeminence.

XIV.

Voltaic Electricity (*continued*).

Very soon after the invention of the first form of galvanic battery, such as we have just described it, it was found that, however strong the current obtained from this battery might be at starting, it soon began to weaken, and eventually almost entirely ceased. This fact naturally led to further investigation, which has resulted in the invention of various forms of cell, each of which has some special feature in its construction, intended to maintain the current at its original strength. To understand the principles upon which the effective working of these various forms of the galvanic battery depend, it will be necessary for us to clearly comprehend the nature of the changes which take place in the ordinary cell and tend to weaken its current.

Falling off of voltaic current.

As we have already explained, the generation of a current in an ordinary cell, comprising a plate of zinc and a plate of copper, immersed in acidulated water, and connected by a wire outside the liquid, depends upon a chemical action which takes place in the liquid, whereby the molecules of water are split up into their component atoms of oxygen and hydrogen, the former uniting with the zinc, the latter being given off in bubbles of gas at the copper plate.

Now, as we have already seen, the voltaic current thus generated depends upon the fact that the zinc exerts upon the oxygen of the water a very powerful attraction, which causes it to leave the hydrogen atoms to which it was united and to combine with the zinc, the released hydrogen passing to the copper plate and there being given off in the shape of bubbles of gas, no chemical affinity, sufficient to cause combination, existing between the hydrogen and the copper; further, there is reason to believe, from the fact that like electricities repel and unlike attract each other, that not only are the metal plates of the cell charged with opposite electricities, but that the atoms of which any compound such as water is composed are likewise charged with opposite electricities, the hydrogen in this case being *positive* and the oxygen *negative*.

Causes of loss of intensity in current.

Upon such an assumption as this it is of course easy to understand the production of a current in an ordinary cell, and to discover the causes of its diminution. The positively charged hydrogen turns towards the negative copper plate, while the negative oxygen goes to the positive zinc. The oxygen uniting with the zinc, and the product of this combination being dissolved in the water, the positive plate is kept clean, and the zinc is therefore always

Chemistry of the voltaic cell.

ready to attract fresh atoms of oxygen. Not so the copper plate. Here no combination takes place with the evolved hydrogen, and consequently the negative pole speedily becomes covered with a thin film of hydrogen gas. This film of gas acts injuriously on the current in two ways. First, gases being almost perfectly impenetrable by low tension electricity, this film of hydrogen to a great extent interrupts the circuit. Secondly, the hydrogen film being *positive*, we have virtually in the same cell two positive plates opposed to each other, which of course tends to prevent any current from passing; as, moreover, the hydrogen film is even more positive than the zinc plate, it tends to give rise in the liquid to a current from the copper to the zinc, which is of course in direct opposition to the normal current due to the zinc and copper pair.

To this so-called *polarization* of the copper plate the falling off in power of an ordinary cell is mainly due, but amongst other minor causes may be mentioned the dissolving of the zinc in the liquid, which neutralises the acid present.

Other causes of loss of intensity.

It will be seen, then, from the foregoing considerations that the main object to be kept in view in devising a form of constant battery is the elimination of the hydrogen film, and we will now proceed to notice some of the most successful ways in which this has been effected.

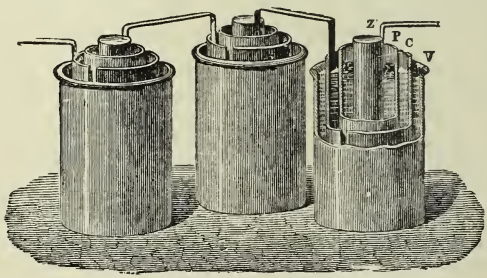


FIG. 48.—DANIELL'S BATTERY.

The form of constant battery which least departs from the original voltaic cell is that known as Smee's, and consists of a cell containing dilute sulphuric acid. In this cell are placed two plates of zinc amalgamated with mercury, and between these two a thin plate of platinum or silver, on which platinum in a very fine state of division has been deposited. The two plates of zinc and the silver or platinum plate are fastened to a bar of wood, which rests by its ends upon the top of the cell. This form of cell is found to be very successful, the accumulation of hydrogen upon the negative plate being to a great extent prevented by the roughening of the platinum or silver by the deposition upon it of the finely-divided metal.

Smee's battery.

Another form of "one-fluid" battery is that known as Walker's, and which differs from Smee's battery in the substitution of gas carbon for the platinum.

Walker's battery.

The most successful of constant batteries are, however, those in which *two* exciting liquids are employed instead of only one. Of these the first which was invented, and one which is still very extensively used, is that known as Daniell's, and was first invented in 1836. Fig. 48 represents this form of galvanic battery, and the front portion of one of the elements is represented as being removed in order that its different parts may be more clearly shown. A glass or porcelain vessel, V, is filled with a saturated solution of sulphate of copper (bluestone or blue vitriol), and in the centre of this is placed a small jar or cell of unglazed and therefore porous earthenware, P. Outside this porous cell, and therefore in the saturated solution of sulphate of copper, is placed a sheet of copper, C, bent round to the shape of the cell, so as to form a hollow cylinder without top or bottom. Upon the upper part of this cylinder a small shelf, perforated by holes, is formed, and upon this crystals of sulphate of copper can be laid, the object of which will be presently seen. The porous cell is filled with dilute sulphuric acid (about one part of the strong acid to twelve parts of water), and standing in this dilute acid is a small cylinder of amalgamated zinc, Z, of similar shape to, but of course smaller than, the copper cylinder C. Two thin strips of copper, are fixed respectively to the copper and zinc cylinders of each element, and serve to connect the cell with its neighbours when used as a part of a battery, or as the poles of the cell when it is used singly.

Daniell's battery.

A modification of this cell is frequently used, in which the copper-plate of the battery is made to do duty for the porcelain or glass cell, as in the other case.

Fig. 49 represents this modification of the Daniell cell, and fig. 50 represents a transverse section of the same element. From these diagrams it will be easily seen that the copper plate AA, instead of being a hollow cylinder without a bottom, as in the form of cell just described, is made into a complete jar, and thus itself contains the sulphate of copper solution, avoiding the necessity of a porcelain or china cell. The other parts of the cell are the same as before; BB is the saturated solution of sulphate of copper; CC is the porous cell; DD is the zinc cylinder; and E is the dilute sulphuric acid.

Having seen the structure of a Daniell's cell, it now remains for us to investigate its action and to see how the current which it produces is maintained constant. Now, as in the original form of voltaic cell, the dilute sulphuric acid unites with the oxide of zinc (formed by the union of the oxygen evolved at the zinc pole with the zinc), and forms sulphate of zinc. The disengaged hydrogen of the molecule of sulphuric acid immediately adjacent to the zinc plate reacts upon the next neighbouring molecule

Principle of the Daniell's cell.

and displaces its hydrogen, hydrogen gas at the immediate moment at which it is disengaged from a compound, or as it is usually expressed when in its "nascent" condition, having a greater power of exciting chemical action than at any other time. The hydrogen displaced from the second molecule of sulphuric acid reacts in like manner upon the third, and so the process goes on from molecule to molecule until the porous cell is reached. Here the nascent hydrogen meets with the sulphate of copper, and displaces from its nearest molecule the copper, forming with its other atoms sulphuric acid; and this copper, reacting upon the copper of the next molecule, displaces *its* copper, and so the process is carried on and the molecule adjacent to the negative plate deposits its copper upon the copper plate.

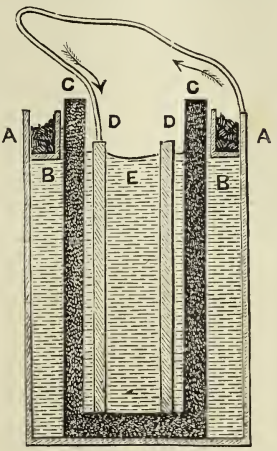


FIG. 49.—MODIFICATION OF DANIELL'S BATTERY.

By this it will be seen that in the outer cell sulphuric acid is formed, which of course tends to replace the sulphuric acid used up in the porous cell, while the copper plate is increased by the deposition upon it of the copper resulting from the decomposition of the sulphate of copper, which latter is the only material really used up in the working of the battery. To replace this used-up salt, crystals of sulphate of copper are placed upon the shelf attached to the copper pole. The amount of sulphuric acid liberated in the outer cell is regular, and is proportional to the acid used up in the porous cell, which causes the action of the latter upon the zinc to proceed regularly and to keep the current constant. The porous cell is employed to prevent the liquids from mixing together thoroughly, but at the same time to allow the current to pass.

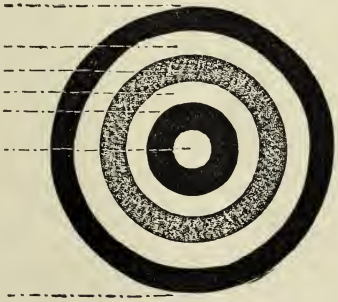


FIG. 50.

We may add here a biographical note regarding the inventor of this battery. It will serve as a breathing space before continuing the subject which so far has engrossed our attention. John Frederick Daniell was born in London on the 12th of March, 1790, and died there on the 13th of March, 1845. In 1816 he founded, in connection with Professor Brande, the *Quarterly Journal of Science*, of which they published the first twenty volumes. After about the year 1831 he gave his attention principally to voltaic electricity. In 1836, in a paper communicated to the Royal Society, he described his improvement in the voltaic battery, by which he showed how a powerful continuous current may be kept up for an unlimited time. He was the only person who ever received the three medals in the gift of the Royal Society.

XXXIX.

SYNTAX (*continued*).

§ 238. *Adverbs.* (*a*) Negation, (*b*) interrogation and affirmation—use of auxiliary *Do*, (*c*) *ever* and *never*.

§ 239. *Prepositions.* (*a*) Government and position, (*b*) joined with verbs, (*c*) lists of prepositions following certain words.

§ 240. *Conjunctions.*

§ 238. **Adverbs.**—(*a*) In modern English the absolute rule is not to use two negatives in one sentence, "we must not deny our denial"; thus, "I *don't* know *nothing* about it" is now vulgar, though the usage was formerly common and good. (See before, § 207, *b*.)

Excluding the verb *to be*, a peculiarity of modern English syntax is in the usage as to adverbs of affirmation and negation; we rarely use them now without the help of an auxiliary verb, especially of DO. *Negation:* I cannot come, He may not eat, They do not sleep, You would not care, I know no more, Tom will not learn. Try to make these sentences without the auxiliary: *I come not*, *He eats not*, etc. We understand them, but they all sound old-fashioned, except *I care not*, which with *I dare not*, *I doubt not*, and one or two others, form exceptions to the rule now almost universally in use. In the case of *to be* the negative belongs rather to the completion of the predicate—noun, adjective, or adverb—than to the verb: This is *not good*, He is *not a man*, John is *not there*; it stands here, as with the others, immediately after the auxiliary. "The wicked are not" (Prov. xii. 7); "Because they are not" (Matt. ii. 18).

Many instances of the old use of *not* without an auxiliary are found in the Bible, Shakespeare, and other writers.

"Thou fearest me *not*."
Isa. lvii. 11.

"Woman, I know him *not*."—Luke xxii. 57.

"If I go *not* away."—John xvi. 7.

"Pardon me, and *not* impute this yielding."
Romeo and Juliet, Act II., sc. ii, l. 105.

"Neat Terence, witty Plautus, now *not* please."
Ben Jonson to Shakespeare.

When the negation applies to the object rather than to the verb it must be placed close to that object: "I came down, *not to do* mine own will, but the will of him that sent me" (John vi. 38). "I did *not* come to see you, but

your sister," is a common misplacing of the negative—wrong, because in fact "I did come," and the negative applies to the first object.

(*b*) *Question and affirmation.* Interrogatives stand at the beginning of the sentence: Who goes there? The adverb of assent naturally follows the question to which it is fitting answer; it is occasionally an utterance answering some thought understood:

"*Yes*, but the waves seem ever singing," etc.
Song.

In putting a *question*, the old manner was to put the subject after the predicate: "What *went ye* out for to see?" as is now the case in French, German, etc. ("Mangez-vous?" "Was nehmen Sie?") The use of the auxiliary is now the rule; we seldom ask a question in the simple tenses without one, *do* being most in use: Are you going? Do you like it? Shall I give it you? Does he feel sad?"

The use of the helper *do* in both negation and interrogation has greatly increased since the Elizabethan age; then it was employed for emphasis,—

"Horses *did* neigh and dying men *did* groan,
And ghosts *did* shriek and squeal about the streets."
Julius Cæsar, Act II., sc. ii., l. 23 (Abbott).

Or in poetry to fill up a measure, a practice jeered at later by Pope,—

"While expletives their feeble aid *do* join."
Essay on Criticism, Part II.

(*c*) *Ever* is an adverb of time and of degree: "If I ever go there," "However poor I am I will help you." *Never* expresses time only: "We could rarely or never find time."

§ 239. **Prepositions.**—(*a*) These are now all considered to govern one case—the objective: Come with *us*, Go for *him*, All but *me*. In Old English different prepositions governed different cases; but with the loss of case-endings these distinctions were lost too. Yet there are sometimes exceptions, as in the following, where the nominative is used after *but*:—

"Away went Gilpin—who *but he?*"—COWPER.

"There is none other that fighteth for us, *but* only *Thou*, O Lord." *Church Service.*

As a preposition points out the relations between two words, it is not always possible to keep it close to both of them; but it should not be separated far from the word governed. Ex.: "It fell *to pieces*," "I had some *lead* to do it *with*," "A master *in* the *art*." In sentences in which a relative pronoun is the object a common and familiar habit often throws the preposition to the end, as "This is the farmer whom I told you *of*," "A circumstance which he thought *of*,"—where it would be more dignified to say, "of whom I told you," "of which he thought." But when the relative *that* is used, which never takes a preposition before it, the inversion cannot be made:

"The pleasure *that* some fathers feed *upon*."
Richard II., Act II., sc. i., l. 79.

When the relative is omitted, the preposition of course remains at the end. Ex.: The dog I have spoken *of*.

(*b*) It was pointed out before that the sense of some verbs is not complete without a preposition, though it is separate; as *get up*, *go out*, *laugh at*. In the passive form of these verbs the preposition remains close after the verb: I was broken *down*, It was not complied *with*, He shall be confided *in*. These words should be regarded as *adverbial prepositions*, because, especially with intransitive verbs, they show no relation with noun or object, but are confined to verb-modification. I go *out*, She runs *away*, They come *down*, The wall falls *in*, are examples.

(*c*) Custom and the sense of words have brought about that certain prepositions are appropriated to certain verbs, nouns, and adjectives. The following lists may aid the discernment of these.*

Nouns.

Abhorrence *from*.	Martyr *to* (sorrow, etc.)
Affinity *to*, or *between*.	Need *of*.
Compliance *with*.	Observance *of*.
Difficulty *in*.	Occasion *to*, or *for*.
Diminution *of*.	Prejudice *against*.
Discouragement *to*.	Recreant *to*.
Exception *to*.	Resemblance *to*.
Hold *of*, or *upon*.	Regard *to*, or *for*.
Martyr *for* (a cause).	Taste *for*.

Adjectives (and participles).

Adapted *to* (thing), *for* (purpose).	Disappointed *in* (what we get).
Averse *to*.	Disappointed *of* (what we don't get).
Conformable *to*.	Free *from*.
Consonant *to*, or *with*.	Glad *of*.
Convenient *to*, or *for*.	Independent *of*
Conversant *with*.	Prejudicial *to*.
Dependent *on*, or *upon*.	Replete *with*.
Derogatory *to*.	True *to*, or *of*.
Different *from*.	Worthy *of*.

Verbs.

Absolve *from*.	Differ *from*.
Accord *with* (intrans.)	Dissent *from*.
Accord *to* (transitive).	Disapprove *of*.
Accuse *of* (a crime).	Expert *at*, or *in*.
Accuse *by* (a person).	Frown *at*, or *on*.
Acquit (persons) *of*.	Insist *upon*.
Agree *with* (persons).	Involve *in*.
,, *to* (things).	Made *of*, or *for*.
Attend *to* (business).	Marry *to*. [is old).
,, *upon* (a person).	Prevail *upon* (*against*
Bestow *upon*, or *on*.	Profit *by*.
Boast *of*.	Provide *for*, or *against*.
Call *on*.	Reconcile *to* (person).
Change *for*.	,, *with* (state-
Confer *on* (a matter).	[ment).
,, *with* (a person).	Resolve *on*.
Confide *in* (intrans.)	Send *to* (place). [son).
,, *to* (trans.)	,, *for* (thing or per-
Conform *to*.	Smile *at*, or *upon*.
Comply *with*. [sons).	Swerve *from*.
Correspond *with* (per-	Think *of*, or *on*.
,, *to* (things).	Thirst *for*, or *after*.
Couple *to*.	Wait *at* (place).
,, *by*.	,, *on*, or *for* (person
Derogate *from*.	or event).

The sense must be consulted when there is

* The lists are compiled principally from those given by Angus and Daniel.

any doubt. We should not say "This book is different *to* mine," but "different *from*," because one thing differs *from* another, not *to* it. We should not "send for our boots *from* London," because we send *to* a place, and *for* a thing.

§ 240. **Conjunctions** join sentences. They do not govern—that is, influence the forms of other words; but they usually connect nouns and pronouns in the same cases, and verbs in moods and tenses of one sort, accordant to their predicates and subjects: "Give it to him and me" (him and me in the accusative case); "She must weep *or* she will die" (indicative mood); "He would be great *if* he were good" (subjunctive mood); "She will come *if* occasion serve" (*indefinite* tenses, fut. ind. and pres. subj.); "This is your gift, *else* I am much mistaken."

A few conjunctions have special functions: *than* follows the comparative of adjectives and adverbs, when not preceded by *the*—"This is *more* desirable *than* that," "It is nothing *else than* robbery," "He is none *other than* Thomas." The relative conjunctions *that* and *what* introduce noun clauses in sentences: "He sees *what* we do," "I cannot tell *what* to say," "They said *that* they were sorry." *That* often follows the adverb *so* and the adjective *such*: "Mary had *such* trouble *that* she became ill," "The sun is *so* bright *that* we are dazzled." Or *such* may be followed by *as*—"I never saw *such* a flower *as* that."

Emphasis may occasionally be given to a description by the repetition of conjunctions; but force and energy is better ensured, in a long narration consisting of words or clauses, by omitting the conjunction till the climax. In the following lines on the power of music only one out of seven conjunctions is expressed:

"Warriors she fires with animated sounds,—
Pours balm into the bleeding lover's wounds;
Melancholy lifts her head,
Morpheus rouses from his bed,
Sloth unfolds her arms and wakes,
Listening envy drops her snakes;
Intestine war no more our passions wage,
And giddy factions hear away their rage."

POPE, *Ode on St. Cecilia's Day.*

BOTANY.

XL.

VARIOUS ORDERS (*continued*).

A VERY interesting particular in connection with certain orders is that, while having their maximum in some distant region, they establish outposts, as it were, near to ourselves, thus giving an idea of the splendours at home, and inviting us to go and see. Such a one is the lovely order constituted of the water-lilies—a family having its chief seat in the Indies, with delicious forms at the Cape of Good Hope, in the river Nile, and in the streams and lakes of North and South America, but identified also with Old England. Nothing in our indigenous flora, gives an air to the country so thoroughly oriental as the common white water-lily, the Nymphæa alba. The queenliness is like that of the swan among aquatic birds, or that of the pearl among the treasures of the jewel-box. The order is one of the few which are denizens purely of the fresh waters; and although among the others there are often very charmingly beautiful plants, not one of them in the aggregate presents so much that is admirable as the family before us. Botanically, the water-lilies are nearly related to the poppies and the Ranunculaceæ. They are exogens, with flowers formed upon the same general plan, having calyx, hypogynous petals and stamens, the latter usually very numerous, and a capsular fruit of many carpels, with abundant seeds. Like the two families named, they are distinguished also for the rosaceous look of the flowers, when polypetalous, and for presenting all the colours usual in plant bloom, including the softest and tenderest azure. Like the poppies and the pæonies, they are remarkable also for the magnitude of their flowers, these three races going equal shares in regard to dimensions. The flowers of the great South American water-lily, cultivated in the hothouses of botanical gardens, where there is room enough for a tank, are seldom less than eight or nine inches across, and often much more. The red and blue water-lilies of the Nile and the Cape are constant rivals in this respect, and our own English *alba* is never far behind. The leaves also are sometimes enormous. Those of the Victoria frequently have a diameter of four or five feet, supplying a ready explanation of the comparative infrequency of the plant, since it is only here and there that room can be spared for such a monopolist. None of these admired plants are in any degree deleterious. One or two, on the other hand, are counted with the economic. It is enough for them that they are the delight of the poet, and of all who love the tranquil and shaded pathway by the quiet river, or the still green walk along the borders of the mere. One of the most wonderful and interesting plants in the world is, if not actually a member of this family, the type of one scarcely distinct from it. This is the Nelumbo, the consecrated water-lily of the Indian rivers, transferred thence in times immemorially remote, to the Nile, and subsequently lost from that stream for probably at least a thousand years. The Nelumbo is the flower almost certainly intended in the account of the building of Solomon's house, when it is said that "upon the top of the pillars there was lily-work." For this flower was used, without question, as a model for decorative architectural work, both in ancient Egypt and at Nineveh, and that it should be employed at Jerusalem by Hiram was no more than would be anticipated. The great circular leaves are lifted above the surface of the water to a height of from three to five feet, upon stalks like reeds. They are perfectly horizontal, and resemble green tables, with a dimple in the

The Nymphæaceæ.

centre. The flowers are elevated to a height nearly equal. They are pink and white, rose-like, at least nine inches across, and exhale a mingled odour of anise and mignonette. The seed-pod is absolutely unique, resembling an inverted cone, while the flattened base presents a number of cavities, each large enough to hold an almond-like seed of good flavour. These seeds were valued as food by the ancient Egyptians, and are to this day an important article in various parts of tropical Asia. The singularity of the seed-pod has induced various botanists to consider this wonderful plant worthy of isolation, and the type of the order called by them Nelumbiaceæ. A smaller species of the same genus, with yellow flowers, occurs in North America.

The mention made in the preceding paragraph of the poppy seems to invite, before going further, special mention of its very interesting family. By no means extensive, it is still one of the orders entitled to early mention, from its containing the celebrated plant which yields *opium*—one of the two queens of vegetable medicines. It consists solely of herbaceous plants, and these are, very generally, slight-built and short-lived, though gay, during their brief existence, with bloom of some brilliant colour. The flowers are normally tetramerous, with very numerous free stamens, though sometimes elegantly trimerous, as in that extremely pretty garden annual, the Platystemon. There are examples, also, of non-development of petals, as in the Bocconia. The fruit is capsular, though by no means always so conspicuously so as in the common poppy. In the celandine and some others we have indeed a close approximation to the silique of the Cruciferæ, only that in the papaveraceous pods there is no replum. The qualities of this order are narcotic, and sometimes acrid, though many of the species are inert. Opium, the product which is quite enough to give dignity to this little order, is obtained from the Indian *Papaver somniferum*, long since naturalized all over western Europe, and a frequent inhabitant of English cornfields. The great white flowers have a purple spot at the base of every petal. The foliage is of a peculiar glaucous hue, and, excepting to a slight extent upon the upper portion of the peduncle, the whole plant is free from hairs or bristles. In India and China, where the opium is prepared, as soon as the plant is nearly in bloom, gashes are cut in the parts just below, the milky sap exudes, and soon hardens to the consistency of cheese, when the lumps are picked off, and kneaded into a mass. This is the ordinary opium of commerce. To convert it into laudanum, it is dissolved in spirits of wine. "Morphia" is the essential principle of the opium, representing one of the vegetable alkaloids. Poppies and their allies are, as regards ornament, noted chiefly for their gaudiness. How fine the effect produced by great masses, and even by a sprinkling of the common corn-poppy, is well known.

The Papaveraceæ.

FIG. 203.—WISTARIA.

While the Nelumbo takes us to the ancient kingdom of the Pharaohs, in relation to the mythology and art of the men who built the pyramids, we have another association with them in the common flax-plant, the type of the delicate and pretty little family called Linaceæ. Did not this one stand in the front, there would be little to say respecting the remainder, none of the species, except the *Linum usitatissimum*, being possessed of economic value. All are herbaceous, unless the perennials now and then become slightly ligneous. The leaves are simple and undivided, alternate and exstipulate. The flowers, which consist of five very lightly attached petals, are regular, blue, red, yellow, or white, with five stamens, and a solitary and superior ovary. The last-named is remarkable in consisting of five two-seeded carpels, which, when ripe, separate completely and leave no sort of central axis. Common flax would seem to be a native of the ancient country just mentioned, though possibly the original diffusion may have been wide. In any case it supplies a striking example of capacity for adaptation to various climates, some of the best flax in the world being raised in Russia. When in full bloom a field of flax presents a charming spectacle, the lightness of the stalks and the exquisite delicacy of the tint of the flowers giving features unknown to any other plant of wide cultivation by the

The Linaceæ.

farmer. The reference to flax in Coleridge will be familiar to many:—

"When through its half-transparent stalks at eve,
The level sunshine glimmers with green light."

In gardens, for ornamental purposes, several other species of flax are common; especially the brilliant crimson *Linum grandiflorum*, a native of Morocco.

The wood-sorrels, like the flax-worts, cannot be said to constitute an important order, but the plants are so interesting that they cannot be passed without mention. They are admirably illustrated in the little wild English wood-sorrel, abundant everywhere under the shade of trees, and at once distinguishable by its trifoliolate leaves, and fairy-like bells formed of lilac-veined petals. This is the only indigenous species, though in cultivated land there often comes up another kind, with yellow flowers, long since introduced from some foreign country. The leaves in this one are also trifoliolate, but among the crowd of pretty forms which belong to the Cape of Good Hope and to South America it is by no means unusual to find digitate leaves, while one or two develop little besides phyllodia, resembling those of certain Australian acacias. There are examples also of pinnate leaves, as in the genus Biophytum. In every instance where there has been opportunity of observing, the leaflets of the trifoliolate species are exquisitely sensitive to light, bending downwards and rising according to the force of the sunbeams. The singularity is still not so much in their moving, change of position being a common phenomenon in the trifoliolate leaves of many leguminosæ; in the common white or Dutch clover, for instance. It consists, in the oxalids, in the *way* they move. For here, in the wood-sorrel, instead of advancing or moving forwards, so as to bring the faces together, or nearly so, the leaflets droop downwards, exposing the faces and hiding the backs. There is no known cause for this curious peculiarity, which may be compared with the backward movement, instead of forward, in certain Compositæ, when the hour of repose arrives, and which makes them seem to be withered or dying, instead of simply sleeping after an odd and wayward manner of their own. The leaves of the oxalids, as their Latin name implies, and the English name as well, contain a rather considerable quantity of acid, but they scarcely possess flavour enough to enter agreeably into salads. Some of the exotic species have rather large tuberous roots, which, when improved by cultivation, are esculent. But in our own country little attention has been paid to them. The seed-capsules are exceedingly curious, the five carpels having each an elastic lining, a kind of pocket, which, when the seed is quite ripe, inverts itself in such a way, and so rapidly, as to jerk the seed to the distance of fifteen or twenty inches. Hence, when such an Oxalis as the beautiful golden yellow *Valdiviana* is once introduced into a rustic portion of the garden, it very soon diffuses itself, coming up in the most unexpected places. The seeds of the Oxalids are very pretty objects for the low-power microscope.

The Oxalidaceæ.

FIG. 204.—FIELD GENTIAN.

A very beautiful order of herbaceous and undershrubby plants, familiar to every one in the lovely representatives found universally in gardens and greenhouses, Geraniums rank next in popularity to lilies and roses, and deservedly so. In England there grow wild nearly a dozen of the smaller kinds, including the pretty herb-Robert of the hedgerows, and the cranesbills, in their various species, blue, crimson, and pink. In several other temperate countries of the northern hemisphere, herbaceous geraniums are equally plentiful; some of the very prettiest, valued by florists, are from the cooler parts of the East Indies. Whether herbs or undershrubs, the leaves are simple, but usually much

The Geraniaceæ.

FIG. 205.—ASH-TREE.

divided, either in a palmate or a pinnate manner, and are provided with stipules, which often add considerably to the engaging complexion. The flowers—very generally produced in umbels or umbellate clusters, though its main peduncle sometimes bears only one or two—are formed of five free petals in a five-lobed calyx, with normally ten stamens, and five ovaries which surround the base of a peculiar pillar, a sort of elongation of the peduncle. When ripe, the ovaries loosen themselves, and curl or curve away from the pillar by means of a long arm which reaches up to the apex, discharging as they rise each a solitary seed. A geraniaceous plant of any kind, caught in the act of uncurling its ovaries, is recognized without asking for any other character. The flowers are of almost all known colours, but rarely fragrant. Amends are made for this deficiency by the powerfully aromatic odour of the foliage of many species, evolved more particularly when the leaves are lightly rubbed between the fingers. Now and then, instead of being agreeable, the scent becomes somewhat obnoxious, as in the case of the above-named herb-Robert, the smell of which has been compared to that of foxes. Three principal genera comprise the ordinary forms: Pelargonium, Geranium, and Erodium. The Pelargoniums are the semi-ligneous species from the Cape of Good Hope, with irregular flowers and only seven perfect stamens, which go by the name of geraniums with cultivators. These include all those cherished in greenhouses, and the common scarlet ones, "the Horse-shoe," etc., of the open garden. The Geraniums, in the restricted botanical sense, have *regular* flowers with ten stamens, and are all herbaceous. These, for distinction's sake, are best called "cranesbills." The Erodiums, of which there are but few, resemble the preceding in most particulars, but the arm of the carpel, in detaching itself from the pillar, takes a most beautiful spiral form, and if moistened uncurls again. Three of these are indigenous to our own island. None of the Geraniaceæ are in the slightest degree deleterious. Their usefulness, on the other hand, consists solely in their value as decorative plants.

XXXIII.

Practical Application.

(1) VOCABULARY XVII.

LES ANIMAUX—*Animals.*

[1. Name of the male; 2. do. of the female; 3. do. of the young; 4. do. of the special cry.]

1. âne, *ass;* 2. ânesse; 3. ânon; 4. braire, *to bray.*
1. bélier, *ram;* 2. brebis; 3. agneau, *m.* agnelle, *ewe lamb,* agnelet, *lambkin;* 4. bêler, *to bleat.*
1. bouc, *goat;* 2. chèvre; 3. chevreau, *kid,* chevrette, *f.;* 4. chevroter.
1. canard, *drake;* 2. cane; 3. caneton, *m.*, canette, *f.;* 4. nasiller.
1. cerf, *stag;* 2. biche; 3. faon; 4. bramer, râler (*sp. of the fawn*).
1. chat, *tom-cat;* 2. chatte; 3. chaton; 4. miauler, *to mew,* ronronner, *to purr.*
1. cheval, *horse,* étalon, *stallion;* 2. jument; 3. poulain, *m.*, pouliche, *f.;* 4. hennir.
1. chevreuil, *roebuck;* 2. chevrette; 3. faon; 4. bramer, râler.
1. chien, *dog;* 2. chienne; 4. aboyer, *bark,* japper, *yelp,* hurler, *howl.*
1. coq, *cock;* 2. poule; 3. poussin, *chick,* poulet, poulette, *chicken;* 4. coqueriquer *or* chanter (*sp. of the cock*); glousser *or* piauler (*sp. of the hens*); piailler (*sp. of the chickens*).
1. daim, *deer;* 2. daine; 3. faon; 4 (*see* cerf *and* chevreuil).
1. dindon, *turkey-cock;* 2. dinde; 3. dindonneau; 4. glouglotter, glouglouter.
1. faisan, *pheasant;* 2. faisane; 3. faisandeau.
1. jars, *gander;* 2. oie; 3. oison; 4. criailler, siffler.
1. lapin, *rabbit;* 2. lapine; 3. lapereau; 4. clapier *or* clapir, *to squeak.*
1. lévrier, *greyhound;* 2. levrette; 4. (*see* chien).
1. lièvre, *hare;* 2. hase; 3. levraut.
1. lion, *lion;* 2. lionne; 3. lionceau; 4. rugir.
1. loup, *wolf;* 2. louve; 3. louveteau; 4. hurler.
1. mulet, *mule;* 2. mule; 4. (*see* âne).
1. ours, *bear;* 2. ourse; 3. ourson; 4. gronder.
1. paon, *peacock;* 2. paonne; 3. paonneau; 4. brailler, criailler.
1. ——*; 2. perdrix, *partridge;* 3. perdreau; 4. cacaber.
1. pigeon, *pigeon;* 2. colombe; 3. pigeonneau; 4. roucouler.
1. rat, *rat;* 2. ratte; 3. raton; 4. clapir.
1. renard, *fox;* 2. renarde; 3. renardeau; 4. glappîr, japper.
1. sanglier, *wild boar;* 2. laie; 3. marcassin; 4. grommeler.
1. serin, *canary;* 2. serine; 4. siffler, chanter.
1. singe, *monkey;* 2. guenon; 4. jacasser, *to chatter.*
1. ——*; 2. souris, *mouse;* 3. souriceau; 4. clapir.
1. taureau, *bull;* bœuf, *ox;* 2. génisse, *heifer;* vache, *cow;* 3. veau; 4. beugler, meugler, mugir.
1. tigre, *tiger;* 2. tigresse; 4. rugir.
1. vérat, *boar;* cochon, *pig;* 2. truie *or* coche; 3. cochon de lait; 4. grogner.

(2) The article of the possessive pronoun (*see* p. 402) is contracted in the masculine singular and plural of both genders with the prepositions *à* and *de*:—

	M. S.	*F. S.*	*M. P.*	*F. P.*
to mine = au mien		{ (à la mienne) }	aux miens	aux miennes
of mine = du mien		{ (de la mienne) }	des miens	des miennes

EXERCISE XLIV.

1. Voici notre voiture "qui arrive" (*here is, carriage coming*), où est la vôtre? Je n'ai pas commandé (*ordered*) la mienne; "j'irai à cheval" (*shall ride*). 2. Je vous dis (*tell*) que mon cousin et les vôtres ont raison. C'est votre avis (*opinion*), mais ce n'est pas le nôtre. 3. Veux-tu (*wish*) être des nôtres? Je "le veux bien" (*do not mind*). 4. Vous avez vu ma bibliothèque (*library*) et la sienne; les aimez-vous mieux que la leur? Vos bibliothèques sont très bonnes, mais la leur est meilleure. 5. Est-ce de mon crayon ou du vôtre "que vous vous servez" (*that you* make *use*)? Je me sers (make *use*) du mien, voilà le vôtre (*there is*). 6. Fais-leur comprendre (*make, understand*) que mes vues ne diffèrent (*views, differ*) pas des leurs. Ce n'est pas mon affaire, c'est la tienne. 7. Avec quel canif

* When the species is designated by the female, one would say *le mâle de la perdrix, de la souris,* etc.; and when there is no special feminine form one would say, *e.g., la femelle de l'éléphant,* or *l'éléphant femelle.*

(*with which penknife*) avez-vous taillé (*mended*) votre plume? avec le sien? Non, je l'ai taillée avec le mien. 8. Vous a-t-elle dit (*tell*) qu'elle écrivait (*was writing*) à mes sœurs après avoir écrit aux vôtres? Elle ne nous a rien dit. 9. Elle ne m'a pas "fait part" (*communicate*) de son projet, "parce que je n'ai pas voulu" (*because, wish*) du mien. 10. Avez-vous pensé (*think*) à mon affaire? Non, je n'y ai pas pensé; je n'ai pensé qu'à la mienne. 11. "Mon petit" (*boy*), qu'est-ce qu'il y a (*is there*) dans ta hotte (*basket*)?* J'y ai deux canards et trois oies. 12. Tes cochons de lait sont-ils à vendre? Ils ne le seront pas de (*for*) trois semaines. 13. "Faites bien mes compliments" (*give my respects*) à madame votre grand'mère, et priez-la (*beg*) d'accepter ce levraut et cette couple (*brace*) de perdreaux. 14. Vos dindons, vos jars et vos paons sont-ils aussi gros que les miens? Je "le crois bien" (should think so). 15. Le marquis de Carabas présente ses compliments à sa majesté et la prie "de vouloir bien" (*to be so kind as to*) accepter trois lapins de garenne (*warren*) et une couple de faisandeaux. 16. Monsieur votre père a-t-il fait bonne chasse (*had good sport*)? Oh! il n'a pas "fait chou blanc" (*or* il n'est pas revenu bredouille = *did not return, come home, unsuccessful*); sa carnassière regorgeait (*bag was overflowing*) de lièvres et de perdrix. 17. Quel âge donneriez-vous à mon ânesse? à juger par ses dents (*teeth*) elle doit avoir (*must be*) une quinzaine d'années. 18. La laie et ses marcassins se vautraient dans une mare (*were wallowing, pool*). 19. Monsieur votre père m'a raconté (*related*) son aventure avec la louve et les louveteaux. 20. Ma chèvre a perdu (*lost*) son chevreau; ta brebis perdra son agneau; notre vache perdrait-elle son veau?

EXERCISE XLV.

1. Is he using (*se sert-il de*) my carriage or his *own?* He uses mine. 2. Are you of opinion (*d'avis*) that your father is right and that hers is right? I am of opinion that my father is never wrong. 3. Are you saying that your sister will not be one of our party? She would much like to (*à*) be one of your party, but her health (*santé*, f.) will not permit (*ne le permet pas*). 4. Do you prefer our greyhound to your own (*yours*)? I prefer (*préfère*) mine to yours. 5. Will they use (*se serviront-ils de*) my mules and horses? They will use the colt and fillies. 6. Make him understand that his views are also mine. 7. Did you mend that pen with his penknife or your own? With my own. 8. Is she to write (*doit-elle écrire*) to her sister after writing to mine? 9. Did she inform you (*vous a-t-elle fait part*) of my project or (of) hers? She has informed me of her own. 10. I told him that I had (*n'avais*) thought neither of his business nor of thine. 11. Girl (*ma petite*), what is there in your basket? I have in it some chickens and young pigeons. 12. He has a canary-cock and a canary-hen for sale. 13. My master sends (*vous fait*) his compliments, and "begs your acceptance of" (*vous prie d'accepter*) a brace of pheasants and a young hare. 14. My lad (*garçon*), give my respects to your master, and give (*fais*) him my best thanks (*remercîments*, m.). 15. Their majesties the king and (the) queen give (*font*) their best thanks to the Marquis of Carabas. 16. Has your brother come home with an empty bag? No, he has shot (*tiré*) one stag, one roebuck, and two deer. 17. To judge by the teeth of your mare I should think that she is not more than four or five years old. 18. Our pigs are wallowing (*se vautrent*) in your pond. 19. Your aunt had related to us her adventure with the monkey "that had got hold" (*qui s'était saisi*) of her dove. 20. Mr. W.'s menagerie contains (*ménagerie, contient*) two lions, three lionesses and their cubs, a couple of bears, one royal[2] tiger,[1] and the young of a vixen that recently died (*qui est morte depuis peu*).

* Strictly *dosser* (Webster), or *creel* (Scotch), basket carried on the back.

XL.

The Commonwealth, 1649—1660.

Immediately after the condemnation and execution of the king, the royal title and rank was put aside in England, not to be resumed for more than eleven years. A decree of the House of Commons declared the House of Lords to be useless and dangerous, and the office of kings unnecessary, burdensome, and dangerous, and therefore to be abolished. A council of state was appointed for carrying on the government. It consisted of forty-one members, including judges, army men, House of Commons men, and peers, with Bradshaw for a president. Milton the poet, whose writings had contributed not a little to influence men's minds in favour of the form of government now set up, was appointed Latin secretary. He continued to discharge the duties of his office after he had been smitten with blindness, the afterwards famous Andrew Marvell acting as his amanuensis. The High Court of Justice took cognisance of offences against the state, much as the Star Chamber had done in former times, and proceeded to try royalists and others concerned in the late rising. The Duke of Hamilton, and Lords Holland and Capel, were condemned to death and executed. The Earl of Norwich and Sir John Owen were brought to trial at the same time; the former was acquitted, the latter condemned, but afterwards reprieved.

New form of government.

Execution of the king's partisans.

The republican form of government was not set up without considerable disturbance, arising from the pretensions of conflicting sects, who brawled and prophesied, disturbing the peace. Foremost among the malcontents was Colonel John Lilburne, the puritan, whose disposition was asserted to be so quarrelsome,

Malcontents; John Lilburne—the Levellers.

that if there were no other person in the world but himself, John would quarrel with Lilburne, and Lilburne with John. He was associated with a sect in the army called levellers, who maintained that all men were equal, and that the private soldier, therefore, had as much right to receive honour as the general: a doctrine somewhat subversive of military order and discipline, as Cromwell appears to have thought; for he put down the levellers sternly and promptly, shooting a ringleader with his own hand, in front of the assembled troops. Several others were tried by court martial and executed. Another sect, to which the disturbance of men's minds in religious matters gave rise, was that of the diggers, who declared that, inasmuch as Adam had been condemned to eat bread in the sweat of his brow, it was the duty of all men to labour with the spade; and they accordingly took possession of some waste lands in Surrey, and began digging industriously, with an entire disregard of the rights of property; but Fairfax put an end to their primitive labours.

THE KEEP, CARISBROOK CASTLE.

The most important of the sects founded at this time was that of the Society of Friends, commonly known as Quakers. It was called into being by the zeal and enthusiasm of George Fox, who went about in imitation of the prophets of old, preaching repentance, and announcing the acceptable year of the Lord; and was destined to do a great work, and to hold its own through much tribulation and persecution, both in the Old World and the New.

The Quakers; George Fox.

In Ireland the news of the execution of the king had caused a great excitement. The country was ready to declare for monarchy rather than the commonwealth; and after the landing of the Marquis of Ormond, who came to proclaim King Charles II., all the fortresses, except the capital, Belfast, and Londonderry, fell into his hands. The whole country was in revolt; and Cromwell, invested with the title of lord lieutenant, sailed with an army from Bristol to reduce Ireland to submission.

State of Ireland; the Marquis of Ormond.

Wherever he met with resistance, his course was one of pitiless severity. He found the capital, where Ormond had been defeated before his arrival, open to him; but Drogheda resisted, and was punished by a terrible massacre, the garrison being put to the sword to the last man (September 12), and many men, women, and children, of the inhabitants. Wexford also felt the vengeance of the conqueror on the 9th of October; and these examples struck terror into the country, where the expression "Cromwell's curse" remained as a memento of the feelings of the populace against their subduer. The other places that held out—Cork, Kinsale, and Clonmel, surrendered in turn; and with the capitulation of the last-mentioned town, in May 1650, the subjugation of Ireland was complete.

Cromwell at Drogheda, Wexford, etc.

The unhappy country was treated with merciless rigour. "Woe to the vanquished!" might well be said of Ireland. Many thousands quitted their native land, thousands of the prisoners were transported to the West Indies to work on the plantations; and an extensive scheme of colonisation by English settlers in Ireland, while it secured the supremacy to the English, increased the hatred of the native population against the strangers, differing from themselves in language and religion, who held them in subjection. Ireton, Cromwell's son-in-law, was appointed deputy in Ireland, to complete the work of conquest; and upon his death, which happened shortly afterwards, his authority was transferred to Fleetwood, another son-in-law of the lord general.

Settlement of Ireland.

In Scotland the Presbyterians had acknowledged Prince Charles as their king on the death of his father; and the young monarch, though he considered the chiefs of that party as hard and rigid taskmasters, subscribed to

the Covenant, and for a time cast in his lot with them. Fairfax, sympathising with them on many points of religion, refused to march against them; and the task of crushing opposition in Scotland, as in Ireland, fell upon Cromwell, who entered Scotland with an army of 16,000 men, on the 22nd of July, 1650.

The Presbyterians and Charles II.

Already at the beginning of the year, the Marquis of Montrose had invaded the country with a small force of foreigners, crossing from the Orkneys to the mainland, to encounter defeat in April, at the hands of Strachan in Corbiesdale. Shortly afterwards he fell into the hands of the Covenanters, who hanged him as a traitor on a gibbet in Edinburgh. Montrose's attempt was gallant, but rash and ill-timed; he had, moreover, incurred the suspicion of having caused the assassination of Dr. Dorislaus, the minister of the parliament at the Hague.

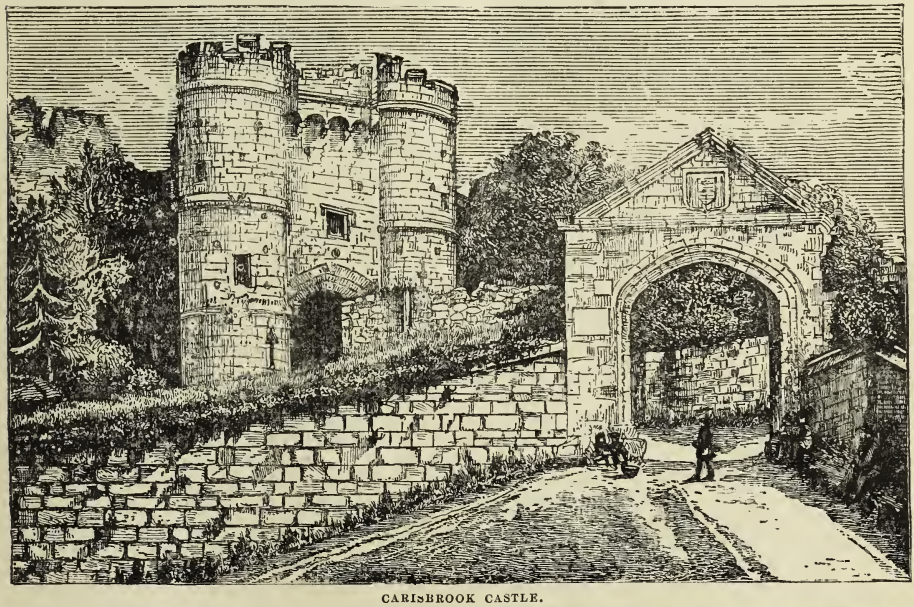
Defeat and death of Montrose.

When Cromwell crossed into Scotland he found General Leslie strongly intrenched near Edinburgh. The country between the capital and the border had been ravaged, so that Cromwell was compelled to fall back upon Dunbar, to be near his fleet and supplies. Leslie pursued him, and took up a strong position on the heights, whence it seemed hopeless to attempt to dislodge him; and the English commander already meditated embarking his army, when Leslie, yielding to the exhortations of the Presbyterian divines in his camp, who adjured him not to trust in the arm of flesh, but to attack the foes in the strength of heaven, was seen moving down from his impregnable station into the plain.

Cromwell in Scotland; Battle of Dunbar.

"The Lord hath delivered them into my hands!" was Cromwell's gleeful exclamation, when he saw this military blunder perpetrated by the foe. He lost no time, but attacked at once; and the 3rd of September was signalised by the victory of Dunbar, in which 4,000 of Leslie's men were slain and 10,000 taken prisoners. This triumph opened to Cromwell the road to Edinburgh. He at once took up his quarters in the city, which capitulated; and here he passed the winter of 1650, triumphant over his foes, but sorely troubled with sickness, suffering from severe and repeated attacks of ague.

Glasgow, as well as Edinburgh, surrendered to the conqueror, who had now crushed the life out of a most formidable rebellion, and had thereby made an important advance on the road that was to lead to supreme power.



CARISBROOK CASTLE.

XLI.

Study on the Interrogative and Relative Pronouns.

The interrogative pronoun WHO? WHICH? must first be regarded as indefinite or general in its meaning, indicating a number not limited or clearly expressed. It is then rendered in German by wer for the masculine and feminine, and was for the neuter. Wer hat das Fenſter zerbrochen?—who has broken the window? Was ſind die beſten Gaben die ich ihm geben kann?—what are the best gifts that

I can give him? This general interrogative pronoun is thus declined:—

	Masc. and Fem.	Neut.
Nom.	wer, who *vairr*	was, what *vass*
Gen.	weſſen, whose *ves'-sen*	weſſen, of what *ves'-sen*
Dat.	wem, to whom *vaim*	(wanting)
Acc.	wen, whom *vain*	was, what *vass*

(As in English, no plural form.)

The relative pronoun is definite, and is declined in the following manner:—

Singular.

	Masc.	Fem.	Neut.
Nom.	welcher *vel'-cher*	welche *vel'-che*	welches, who, which *vel'-ches*
Gen.	welches *vel'-ches*	welcher *vel'-cher*	welches, of whom, of which *vel'-ches*
Dat.	welchem *vel'-chem*	welcher *vel'-cher*	welchem, to whom, to which *vel'-chem*
Acc.	welchen *vel'-chen*	welche *vel'-che*	welches, whom, which *vel'-ches*

Plural.

(All genders.)

Nom.	welche *vel'-che*	Dat.	welchen *vel'-chen*
Gen.	welcher *vel'-cher*	Acc.	welche *vel'-che*

The genitive form deſſen, deren, deſſen, *des'-sen dair'-ren des'-sen* which properly belongs to the demonstrative form, is also frequently used for the relative. The manner of declension, it will be seen, is the same as for an adjective in the first form (guter, gute, gutes—welcher, welche, welches). Often the form der, die, das (with the genitive deſſen, deren, deſſen, instead of des, der, des) is used for welcher. Thus we say Ein Mann, den ich geſtern ſah, a man whom I saw yesterday. Ein Kind, dem ich ein Buch gab, a child to whom I gave a book, as frequently as welchen ich ſah, welchem ich ein Buch gab. Indeed, welcher is most frequently employed to avoid the too frequent repetition of the form „der, die, das."

When a *definite* person or thing is inquired for (or definite persons and things), the form welcher, welche, welches, is used in asking a question. In speaking to two boys we should say „Welcher von euch will dieſen Brief auf die Poſt tragen?" which of you will carry this letter to the post? „Welche von dieſen Blumen ſind die ſchönſten?" which of these flowers are the most beautiful?

Sentences on the Interrogative and Relative Pronouns, for Translation into English.

Wer kann ſagen was im Laufe eines
vair kann zah'-gen vas im lowf'-e i'-nes
Jahres, eines Monats, einer Woche, eines
yahr'-es i'-nes mo'-nahts i'-ner vo'-che i'-nes
Tages, einer Stunde oder einer Minute
tah'-ges i'-ner stun'-de o'-der i'-ner mee-noo'-te
geſchehen kann? Wem überließ der
ge-shay'-en kann vame ue-ber-leess' dare
Kaiſer Karl der Fünfte ſeine Deutſchen
ky'-zer karl dare fuenf'-te zy'-ne doitsh'-en
Staaten? Seinem Bruder Ferdinand.
stah'-ten zy'-nem broo'-der fair'-dee-nand
Weſſen iſt das Haus, fragt er böswmeinend,
ves'-sen ist dass house frahgt air boes-my'-nend
denn er wußt es wohl, ſagt Stauffacher
denn air vusst es vole zaacht stowf-fach-er
von Geſſler, in Schiller's Wilhelm Tell. Wen
fon gessler in schiller's vil-helm tell vain
halten Sie für den beſten Deutſchen
halt'-en zee fuer dane best'-en doitsh'-en
Dichter unſerer Zeit?
dich'-ter un'-zer-er tsite

STUDY FOR READING AND PRONUNCIATION.

In the following study a number of new words will be found to have been introduced. The student is especially requested to note the *compound words*, and by the aid of his dictionary to resolve them into their component parts. The position of the verb, as one of the difficult points in German, or rather one of those in which the construction differs from the English, should also be carefully remarked. Thus, in the first sentence, the verb iſt is placed before and not after its subject dieſer Vogel, because the sentence begins in an inverted order, with a preposition (wegen, and the genitive case governed by that preposition). In the next sentence the verb iſt is in its right place, because the sentence is direct, beginning with the nominative case: wo die Teakbäume häufig ſind. Here the verb is at the end of the clause, because the clause, "where the teak trees are plentiful" is complementary, and therefore dependent, not making a complete sense by itself; indem er ihre Früchte liebt, in the same manner, is complementary, and has the verb at the end. It will be seen that every compound sentence, consisting of different clauses, has one independent clause, where the adverb stands *next to* the nominative, either after or before it according as the nominative comes first in the sentence, or later on; all the other clauses have the verbs at the end. It is worth while to go through the study sentence by sentence, to fix this thoroughly in the mind.

Der Paradiesvogel.

dare pah-ra-deece'-foh-gel

THE BIRD OF PARADISE.

Wegen ſeines prachtvollen Gefieders[1]
vay'-gen zy'-ness prahcht'-foll-en ge-fee'-derrs
Because of its splendid plumage
iſt dieſer Vogel einer der allerſchönſ-
ist dee'-zer foh'-gel i'-ner dare al'-ler-shoen-
is this bird one of the most beautiful
ten. Er iſt hauptſächlich[2] in Neu-
sten airr ist howpt'-zech-lich in noi-
of all. He (it) is chiefly in New
guinea heimiſch, wo die Teakbäume
gee'-naya hy'-mish vo dee tee'-ak-boy'-me
Guinea at home, where the teak trees

häufig sind, auf denen er sich gerne
hoĭ'-fich zint owf day'-nen airr zich gerr'-ne
plentiful are, on which he (himself) gladly
aufhält,[3] indem er ihre Früchte liebt.
owf'-helt in-dame airr ee'-re fruech'-te leept
tarries, because he their fruits loves.
Es gibt[4] Paradiesvögel von der
es giept pah-ra-deece'-foh-gel fon dare
(There are) birds of Paradise from the
Größe einer Lerche bis zu der eines
grös'-se i'-ner lerr'-che bis tsoo dare i'-nes
size of a lark up to that of a
Hähers. Ihr Gefieder zeichnet[5] sich
hay'-errs eerr ge-fee'-derr tsych'-net zich
jay. Their plumage distinguishes itself
nicht bloß durch glänzende Farben,
nicht blohss doorch glen'-tsen-de farr'-ben
not only through shining colours,
sondern auch durch zierliche[6] Formen
zon'-derrn ouch doorch tseer'-li-che forr'-men
but also through graceful forms
und einen sonderbaren[7] Bau aus.
unt i'-nen zon'-der-bah'-ren bough owss
and a peculiar construction (out).
Die Federn auf der Stirne sind kurz
dee fay'-derrn owf dare steer'-ne zint koorts
The feathers on the forehead are short
und meist seidenartig,[8] die Kehle meist
unt myst zy'-den-ar-tich dee kay'-le myst
and mostly silky, the throat mostly
glänzend wie Smaragd oder Gold, die
glen'-tsent vee smah-rahgd oh'-der goldt dee
shining like emerald or gold, the
Seitenfedern in zarte, flatterige
zy'-ten-fay'-dern in tsar'-te flat'-ter-ich-e
side feathers into delicate fluttering
Federbüsche verwandelt,[9] die oft in
fay'-derr-büsch-e fer-van'-delt dee oft in
feather plumes changed, which often in
schimmernde Edelsteine zu endigen
shim'-mern-de ay'-dĕl-sty'-ne tsoo en'-di-gen
glittering jewels to end
scheinen. Der Schnabel ist fest, ziemlich[10]
shy'-nen dare shnah'-bel ist fest tseem'-lich
seem. The beak is firm, about
so lang als der Kopf, zusammengedrückt
zo lang alss dare kopf tsoo-zam'-men-ge-drückt'
as long as the head, together pressed,
und hat neben der Spitze einen Ausschnitt;[11]
unt hat nay'-ben dare spit'-se i'-nen ows'-shnit
and has beside the point a groove;
die Flügel sind lang und stark; der Schwanz
dee flue'-gel zint lang unt starrk dare shvants
the wings are long and strong; the tail
ist gerade und besteht aus zwölf
ist ge-rah-de unt be-stayt' ows tsvölf
is straight and consists of twelve
Federn, von welchen sich oft zwei
fay'-derrn fon vel'-chen zich offt tsvi
feathers, of which themselves often two
drahtförmig verlängern. Nur die Männ-
draht'-for-mich fer-leng'-ern noor dee menn'-
(in) wire form lengthen. Only the males
chen haben das prächtige[12] Gefieder,
chen hah'-ben dass prech'-ti-che ge-fee'-derr
have the splendid plumage
und den Weibchen fehlen[13] auch alle
unt dane vibe'-chen fay'-len owch al'-le
and to the females are wanting also all
verlängerten Federn, sowie den jungen
fer-leng'-er-ten fay'-derrn zo-vee' dane yung'-en
lengthened feathers, so as to the young
Männchen in den drei ersten Jahren.
men'-chen in dane dry errs'-ten yah'-ren
males in the three first years.
Die Geschichte der Paradiesvögel
dee ge-shich'-te dare pah-ra-deece'-foh-gel
The history of the birds of Paradise
war lange Zeit stark mit Fabeln
vahr lang'-e tsite starrk mit fah'-beln
was (a) long time strongly with fables
durchwoben,[14] wozu besonders das mit
doorch-vo'-ben vo-tsoo be-zon'-ders dass mit
interwoven, whereto especially that (with)
beitragen[15] mochte, daß ihre Bälge
by'-trah-gen moch'-te dass ee'-re bel'-ge
contribute might, that their skins
ohne Füße, zum Theil sogar ohne
oh'-ne füss'-e tsum tile zoh'-gahr oh'-ne
without feet, in part even without
Flügel nach Europa kamen und noch
flue'-gel nach oi-ro'-pah kah'-men unt noch
wings to Europe came and still
kommen. Daher entstand[16] denn die
kom'-men dah-har'e ent-stand denn dee
come. Thence arose then the
Meinung, daß die Vögel keine Füße
my'-nung dass dee foeh'-gel ky'-ne füss'-e
opinion that the birds no feet
hätten und beständig[17] in der Luft
het'-ten unt be-sten'-dich in dare luft
had and continually in the air
schwebten,[18] und da sie ohne Füße nicht
shvaib'-ten unt dah zee oh'-ne füss'-e nicht
floated, and as they without feet not
sitzen konnten, so fabelte[19] man, daß sie
zitz'-en konnt'-en zo fah'-bel-te man dass zee
sit could, so fabled one, that they
auch in der Luft brüteten, indem sie
ouch in dare luft brü'-te-ten in-dame' zee
also in the air brooded. while they
die Eier unter den Flügeln hielten u. s. w.[20]
dee ey'-err un'-ter dane flü'-geln heel'-ten
the eggs under the wings held etc.
Als die Eingeborenen[21] sahen, welchen
als dee ine'-ge-bo'-re-nen zah'-en vel'-chen
When the natives saw what
Werth die Europäer auf diese Vögel
vairt dee oi'-ro-pay'-er owf dee'-ze föh'-gel
value the Europeans on these birds
legten, halfen sie noch selbst dazu,
layg'-ten half'-en zee noch zelbst dah'-tsoo'
placed helped they still themselves thereto,
die jene umhüllenden Mysterien[22]
dee yay'-ne um-hül'-len-den mys-tai'-rien
the those (birds) surrounding mysteries
auszuschmücken.
ous'-tsoo-shmük'-en
to adorn (deck out).

REMARKS ON THE FOREGOING STUDY.

[1] *Das Gefieder.* This is an instance of the prefix *ge*, signifying a quantity or collection. *Die Feder*, the

feather; *das Gefieder*, the plumage or suit of feathers: like *der Berg*, the mountain; *das Gebirge*, the chain or system of mountains—as, *das Erzgebirge*, the ore mountains, in the south of Saxony; *das Riesengebirge*, the giant mountains.

[2] *Hauptsächlich*, principally, an adverb, from the noun *die Hauptsache*, the head thing or principal thing; *lich*, as a termination, corresponds to the English *ly*.

[3] *Sich aufhalten*, to tarry, reside, make a stay. Thence the noun *der Aufenthalt*, the stay or residence: *Unser Aufenthalt in Dresden war sehr angenehm*, our residence at Dresden was very agreeable.

[4] *Es gibt*, an impersonal form of the verb *geben*, to give, is an idiom exactly equivalent to the French phrase *il y a* and the English *there is*. The phrase is used in the various tenses. Thus—*Es gibt dieses Jahr viele Aepfel, es gab letztes Jahr fast gar keine, es wird nächstes Jahr vielleicht wenige geben*, There are this year many apples, there were last year almost none, there will be next year perhaps few.

[5] *Sich auszeichnen* is a compound separable verb; from *zeichnen*, to draw, and *aus*. Notice the position of the prefix *aus* at the end of the sentence.

[6] *Zierlich*, an adjective from the noun *die Zier*, the adornment or ornament. Thus *zierlich* is "calculated to adorn or give grace."

[7] *Sonderbar*, peculiar. The verb *sondern* is to sever; thence the English "to sunder." *Sonderbar* is therefore "calculated to separate or sunder."

[8] *Seidenartig*, from *Seide*, silk, and *die Art*, the kind. Thus, "of the nature of silk." Thus *gutartig*, kindly; *bösartig*, malignant.

[9] *Verwandeln*, to change. The verb *wandeln* is to wander: thus, *sich verwandeln*, to wander from one nature to another, to change. *Die Freude verwandelte sich in Schmerz*, the joy was turned into pain.

[10] *Ziemlich* also has the meaning *tolerably, somewhat: Er ist ziemlich spät*, it is tolerably or somewhat late. The original meaning is the English *seemly*.

[11] *Der Ausschnitt*, from *ausschneiden*, to cut out. Thus a section of a book or of a report is often called *ein Ausschnitt*.

[12] *Prächtig*, splendid; from *die Pracht*, splendour, magnificence, beauty. The English word pride, meaning adornment or beauty, is allied to the German *Pracht*. The rose in its pride (splendour).

[13] *Fehlen*, to fail, has various meanings. Originally it means to commit a fault, to fail in duty. *Ich habe jugendlich gefehlt*, I have failed youthfully (committed youthful faults), says Schiller's Mary Stuart. Then it means to lack, to want: *Was fehlt Ihnen?* what ails you? what do you want? like the French phrase *qu'avez vous?*—what (grievance or sorrow) have you? what is the matter? Another meaning is "to be absent": *Es fehlen noch zwei*, two are yet absent.

[14] *Durchwoben*, interspersed or interwoven; from *weben*, to weave, and *durch*, through.

[15] *Beitragen*, to contribute; literally to carry up or bring forward: *bei*, and *tragen*.

[16] *Entstand*, from the verb *entstehen*, to originate, to have a beginning.

[17] *Beständig*, continually, an adverb from *bestehen*, to be steadfast, to continue: *So lehre sie dasz nichts bestehet*, so let it teach that nought endureth.—Schiller's "Song of the Bell."

[18] *Schweben* means, literally, to swing to and fro; frequently to soar.

[19] *Fabeln* is here used as a regular verb: *Man hat viel über den König Artur gefabelt*, people have fabled much concerning King Arthur.

[20] *u.s.w.* These letters stand for the words *und so weiter*, and so onward.

[21] *Der Eingeborene*, the native, the man born in the country.

[22] *Die jene umhüllenden Mysterien*. This is an instance *of the adjective* form of phrase, by which the use of the verb and of the relative pronoun *who* or *which* is dispensed with; literally "the those (birds) surrounding mysteries," instead of *die Mysterien welche jene umhüllten*, the mysteries which surrounded those (birds).

OCELOT.

ZOOLOGY.

XIV.

The Lion.

Whether or not we adhere to the opinion of many modern naturalists and hunters, that the lion is less noble or courageous than was formerly thought, and that much of his renown is due to the long hair of the head and mane in the male, and elevate the tiger to the front rank for terrifying and uncompromising qualities, it is evident that these two hereditary peers have in the course of time agreed to diverge, if not to differ, and to prosecute their avocations for the most part in different quarters of the globe. The royal tiger does not invade the African territory of the lion, but reigns

Which is the king of beasts?

undisturbed in most of India and central and eastern Asia. Although varieties of the lion are found in Bengal, in Guzerat, in Persia, and Arabia, these at present do not to a great extent cross the path of the tiger. But the range of the lion even in historical times was far more extensive, reaching over much of southern Europe, Asia Minor, and Syria. The killing of lions by Samson and by David in Palestine are recorded in well-known Scriptural records.

The general tawny colour of the lion contrasts much with the magnificent spots and stripes of many other cats. Note another peculiarity in lions,—the little bush of hair at the end of the powerful tail. The colour of the hair over the body varies somewhat in different localities,

Colour.

unsuspecting prey, which is the object of search of the lion. Thus we can understand that Livingstone, who on the whole disparages the lion, was a man whom even such a creature could not meet in open day without quailing. Yet no doubt a young lion, like a young tiger, before dangers and escapes have taught him the perfection of caution, is more reckless in attack; and it is natural that, armed with strength sufficient to strike down an ox with one blow of his fore-paw, and to carry his victim off with great speed, able to terrify so intensely by his magic roar, no hostile power in the forests should appear formidable to him. But we may assume that the present generation of lions do not learn contempt for

Travellers' accounts.

HORNED SCREAMER. JAGUAR. TAPIR.

but never becomes black except in the mane and tail-brush; it varies also with age.

The length of a full-grown male is about ten feet from nose to tip of tail; and his weight about four and a half hundredweight. The head is to a remarkable extent characterised by the power and strong leverage of the muscles for biting, and for holding the jaws tightly closed.

Size.

It is not easy to reconcile various travellers' accounts of the demeanour, nature, and habits of the lion, derived as they must be from experiences in vastly different circumstances. No doubt the courage and the strength of will of the traveller himself influence both his narrative and the behaviour of the beast towards him. Moreover, the hunter cannot voluntarily place himself in the position of an man with his rifle by their experience of him. The night, unless moonlit, is the lion's hunting time. By day he sleeps, after his appetite has been sated with flesh.

The lioness's mate is chosen usually after a combat among the suitors; the lion cares much for and is faithful to his partner and her whelps. The cubs hunt for themselves from about a year old, having been first instructed in the arts of discovery and slaughter of prey; at about three years the young lion may set up for himself; he is full grown at eight, and lives till twenty or more.

The lion's whelps.

The Tiger.

The tiger is really somewhat larger and more powerful than the lion, according to the best

authorities; but lacks the mane and the long hair on the head, which characterise the African tyrant. The round face, the long tactile bristles of the face and cheek, and the more perfectly flexible body, the tail without the tuft at the end, and the very special colouring, are the principal marks of the tiger. The predominant colour is a tawny-yellow; but the variegation of this with vertical black stripes, reaching to different lengths down the side of the body, and the irregular rings and lines of black on head, legs and tail, give rise to an appearance of intense beauty. There are white patches on ears, face, and forehead, and also on the belly, which much enhance the general effect. Large male tigers reach from ten to twelve feet in length; females from eight to ten feet.

Colour.

There are no very distinct varieties of tiger known, although the creature ranges as high as 50° north latitude, and east and west throughout Asia, and in the largest Malayan islands. In the more mountainous regions, and near its northern limits, it possesses more hair.

We might conclude from the fact that the tiger has persisted and flourished so long in the midst of crowded populations, many of whom have possessed more than an average cleverness, that the tiger actually combines unscrupulously-exerted strength, and capability of worsting men's plans and attacks to a marvellous degree. The numbers of cattle destroyed by tigers are far greater than those eaten by them. Many districts and villages in India have been deserted at times in consequence of tigers' raids; and the greater ferocity of the tigress than of the lioness, her habit of killing largely to teach her young to kill, and the wanton havoc committed by the young when first enjoying their full powers, may well add to the dread felt by the populations suffering under such bondage. But certainly the destruction of human life by the tiger is the most terrible fact concerning him, and it testifies to an innate cruelty of disposition. Again and again have whole families been cut off by one animal; and thus have arisen the superstitious ascription of spirit possession, the fear of mentioning the tiger by name, the idea of the magical or protective powers believed to reside in his whiskers, teeth, or claws, the eating of the heart and flesh as being conducive to courage. There is no ground for imagining that the teeth or claws have any special venom residing in them; the nature of the wound they give is, in the tropics, sufficient cause for serious consequences, when aggravated by fright, fatigue, or injury from so powerful an animal.

Destructiveness of tiger.

Superstitious fears.

LION. CAPE BUFFALO.

However this may be, the sport of killing the tiger has very largely fallen into the hands of the English visitor to or resident in India; and this must be a source of "legitimate influence" of the British mind over the Eastern. This hunting game is nevertheless made possible chiefly by the assistance of elephants, whose mere bulk and impenetrability to ordinary attacks renders them of immense service as vantage ground for shooting. Hunting by day, again, must be taking the tiger at a disadvantage; he is not met on an equality: yet the power he sometimes displays of doing damage when there is a large expedition organised against him, testifies that he will perhaps long remain the most formidable game the hunter can attack.

British influences.

If the tiger's beauty is largely conferred by his stripes, that of the leopard resides in his various-sized blackish spots on lightish-yellow ground combined with an unsurpassed agility and serpentine flow and curve of motion. Africa, the lion's domain, is also occupied by the Leopard, as second in command and in size; its length of body is about four feet, and the tail is nearly as long. It is found over a considerable extent of western Asia, and even in localities in Ceylon and Japan and the great Malayan islands. Its ferocity is not ordinarily nearly equal to that of the lion and tiger; but it is also undoubtedly inferior in pertinacity to other cats of much less size.

The Jaguar rules in Central America, extending south to Paraguay; and although little larger than the leopard, has a countenance far more repulsive; yet its combinations of black spots, many of them in squares and rings, on tawny ground, give it a very handsome appearance. Jaguars haunt the banks of great rivers or lakes; and when they cannot obtain their favourite food, the capybara, they seek other prey indifferently, and have killed many men, cattle, and horses.

Jaguar.

XXXIX.

COMETS (*continued*)

THE group of comets of long period do not require special consideration, for their exact periods and orbits are very imperfectly known, and few of them seem especially remarkable. They are about twenty-five in number, and have periods of from one hundred to some five hundred years. These comets are only visible when in the very small portion of their orbit which lies near to the sun and earth, so that very trifling errors made in observing their position, when in this small portion of their orbits, cause very large errors in the determination of their exact orbits. And from their ill-defined character it is not easy to determine accurately the exact place of a comet. The most remarkable comets of this group are, perhaps, the magnificent comets 1843 (i.) and 1861 (ii.), each of which is supposed to move in an orbit with a period of about 400 years.

Comets of long period.

Some of the finest comets, however, which have been seen, are probably mere visitors to the solar system, moving in either parabolic orbits or in elliptic orbits of such immense dimensions that, before reaching their aphelion, they come under the influence of the attraction of some other sun and so return no more. The principal of these comets seem to have been the following :—

Extra-solar comets.

1264. (i.) An exceedingly brilliant comet, visible during the whole summer, and having a tail stretching right across the heavens.

1472. (i.) A brilliant comet which was visible during most of the winter. It came very close to the earth, and possessed a long broad tail. During the middle of January it was said to have been conspicuous even during the day.

1618. (iii.) A celebrated comet visible for over a month during the middle of the winter. It was noteworthy from its great brilliancy and fine tail, which was said to be decidedly reddish in tinge. When at its finest it had a tail over 100° in length, and the nucleus was distinctly seen in broad sunlight. It was the first great comet seen through a telescope.

1680. (i.) Conspicuous throughout the entire winter, as a brilliant comet, with a long bright tail. It has been thought to be a comet of comparatively short period.

1744. (i.) This was the finest comet of modern times, and was visible during the entire winter and early spring. It had a bright nucleus and a widely forked tail; indeed, Cheseaux ascribes to it no less than six tails at one time, probably minor divisions of the principal one.

1769. (i.) Visible during the spring. A conspicuous object with a long curved tail.

1811. (i.) One of the most celebrated on record, and remained visible for considerably over a year, being very conspicuous in the northern heavens during the autumn of 1811. It had a very brilliant nucleus, and a long broad tail, with bright edges and a fainter interior. A figure of this comet has already been given (vol. i., p. 789).

1843. (i.) An exceedingly brilliant comet, with a very long tail, which became suddenly visible in the southern hemisphere in February 1843. It is noteworthy for its very close approach to the sun, at its perihelion being distant scarcely a quarter of a million miles from the surface of the sun.

1858. (vi.) Donati's comet. One the finest of this century. It was discovered on June 2nd, near λ Leonis, as a faint nebulous object, being then nearly 240,000,000 miles' distance from the earth; but it slowly became brighter, and during the early autumn of 1858 formed a very conspicuous object, with a brilliant nucleus and a fine broad tail. (See figure on page 405.)

1861. (ii.) This great comet was discovered in Australia in May, but did not become visible in England till June 29th, when its brilliant tail rising above the horizon attracted general attention. It rapidly faded away, however. It is considered very probable that on Sunday, June 20th, the earth passed through the extremity of the tail of this comet, and it is noteworthy that a very peculiar phosphorescent haze was observed during the day.

1880. (i.) This was a remarkable comet, only seen in the southern hemisphere, but bearing a considerable resemblance in its character and orbit to the famous comet of 1843. It approached exceedingly close to the sun at its perihelion passage, and rapidly grew fainter after its discovery. It has been thought to be identical with the comet of 1843 (i.), and perhaps with one of the very similar comets which appeared in 1695 and 1689. If so, its orbit must be rapidly decreasing; and it has been supposed that the comet may in consequence reappear in 1897 and fall into the sun.

What is the true nature of these comets? That is a question which has never yet been satisfactorily answered. It seems certain that there is some close connection between comets and meteors; for close examination has shown that the paths of a number of the most brilliant meteor streams are coincident with orbits of known comets.

Nature of comets.

Thus the great meteoric displays of November, which occur about every thirty-three years, are due to a grand stream of meteors moving in the same orbit as the comet 1866 (i.), and are coincident in their epoch of maximum splendour with the reappearance of the comet. Thus the comet passed its perihelion in 1799, 1833, and 1866, and the following Novembers were the times of the great displays of these meteors. Similarly the brilliant displays of meteors in August are found to be due to a meteor stream moving in the same path as the comet 1862 (ii.) The question arises, then, Are comets only the nuclei of great meteor streams? and are the tails of comets only the denser portion of the

Comets and meteors.

meteor stream? This appears improbable, for we know two or three comets whose orbits intersect that of the earth, but which are not associated with any great meteoric displays. Yet it seems certain that there is some connection.

When comets are examined with the spectroscope, they yield a spectrum of bright bands which seem coincident with the spectrum of incandescent gaseous hydrocarbons. Other bands have at times been suspected which would indicate the existence of nitrogen. Are these comets masses of incandescent gases? This seems inconsistent with physical laws, for it does not seem conceivable that these masses of gas should retain their high temperature and avoid being condensed by the effects of gravitation.

Spectrum of comets.

What, then, is the probable constitution of comets? The most probable hypothesis seems to be that which regards comets to be composed of great masses of highly rarefied gases surrounding a mass of meteors. The attraction of the meteors upon their surrounding gaseous envelope prevents the mass of gas either condensing towards a central nucleus, or rarefying away into space, whilst the mutual action and reaction of the meteors upon themselves and upon their gaseous envelope tends to keep the comet together. In the nucleus these meteors would be more closely packed. and in the tail less closely packed. When examined with the spectroscope, these meteoric bodies being so small — perhaps the largest not many yards in diameter — would reflect or emit so little light that they would escape detection, and only the spectrum of the surrounding gaseous envelope be detected. And the high temperature? It is not certain that these comets really have a high temperature. As will be seen when the nature of nebulæ comes to be discussed, large volumes of gas at even low temperatures may emit sufficient light to yield a spectrum. But as the comets approach the sun it is certain that the meteors will gradually close up and approach very much nearer to each other than in other parts of their orbits, and this approach must lead to a considerable condensation of their gaseous envelopes, and so tend to raise the temperature of the comet very considerably. The hypothesis which is here sketched seems to afford the most probable theory of the constitution of the comets, it being one which, when fully worked out—which cannot be done here—will be found to explain the greater number of the phenomena presented by comets; and, when more elaborately treated, may not unlikely be found capable of explaining all.

Probable nature of comets.

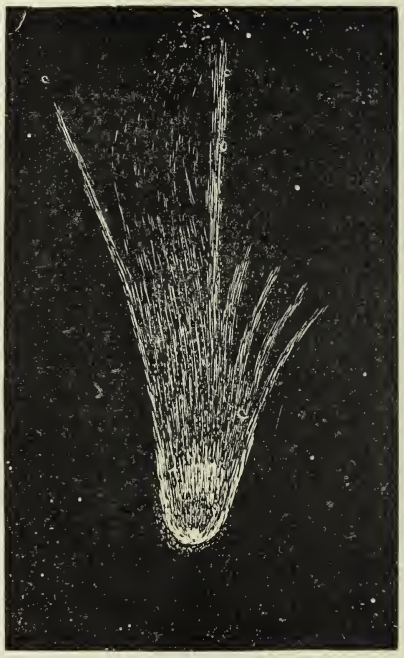


FIG. 96.—COMET OF JULY 1861.

The meteor streams which accompany many comets would then be the results of the disintegration of a comet, for as the meteors became dispersed so would the gaseous envelope, and in course of time there would no longer exist a sufficiently compact mass of meteors to form a comet. Thus the lost Biela comet seems to have completely disintegrated into meteoric masses. We should naturally expect to find, therefore, not only meteor streams without comets—which is very common—but comets which, owing to their being but little disintegrated, were without conspicuous meteor streams.

Disintegrated comets.

METEORS.

We now come to the last division of the members of the solar system —the meteors, and meteor streams.

It has been supposed that the entire solar system is traversed by innumerable streams of meteors, mostly exceedingly small in size, probably ranging in dimensions from the size of peas to about that of a cricket-ball, though some few may reach much larger dimensions, as occasionally falls are recorded of meteors of nearly a ton in weight. The number of these small bodies which cross the earth's orbit must be enormous, for it has been calculated that seven million meteors enter the earth's atmosphere every twenty-four hours, which would correspond to between two and three thousand millions per year. Yet the earth cannot encounter more than one meteor stream for each of the many million whose orbit must pass above or below the place of the terrestrial orbit; and despite these enormous numbers it is calculated that the average number of meteors is less than one per million cubic miles of space, or that, if they were equally distributed, the mean distance between each meteor would be over one hundred miles. But, as stated, these meteors seem to move in streams, and in these streams the meteors are probably much closer together—perhaps in the greater streams not more than two or three miles apart, or even closer. The relationship between the comets and these meteor streams has been already discussed.

Meteor streams.

Enormous number.

When the western sky is observed during the winter or early spring, just after sunset, a lens-shaped stream of faint diffused light will frequently be noticed rising obliquely from the horizon above the place where the sun has set. It rises in a direction showing it to be nearly coincident with the ecliptic, and much resembles in appearance the belt of light called the *Milky Way*. This band of faint light is called the *zodiacal light*. During the autumn months it can generally be seen before sunrise, extending above the eastern horizon, showing it to exist on both sides of the sun. The exact origin of this band of faint light is not known; but it seems probable that it is due to the great number of meteors moving round the sun, as these streams would reflect the solar light in a manner very analogous to what we find in the zodiacal light. Its convex lens-like shape conveying the idea of a broad ring of light surrounding the sun, strongly confirms this. We know that near the sun the numerous meteor streams moving round this body must be much more closely packed than when farther away, and their proximity to the sun must make them shine much more brightly, so we should naturally expect some such phenomenon to exist.

Zodiacal light.

Its origin.

Indeed, the theory of the constitution of comets, which has been already described, would naturally lead to this conclusion, and would explain the resemblance which has been noted between the zodiacal light and the tails of comets, by showing them to be of the same origin.

XV.

VOLTAIC ELECTRICITY (*continued*).

ANOTHER well-known form of constant battery is that invented by Grove, of which a representation is given below (fig. 52). Here A is a glass or earthenware vessel containing dilute sulphuric acid of the same strength as that employed in Daniell's battery; B is a thick sheet of amalgamated zinc bent into the form of the letter U, with a piece projecting from the cell so as to afford a means of junction with the neighbouring element; C is a porous cell containing strong nitric acid; and D is a plate of platinum, which when the cell forms part of a battery is clamped to the zinc of the next element.

Grove's battery.

Here, as in the Daniell's battery, the zinc is in contact with dilute sulphuric acid, and therefore, as before, we shall have sulphate of zinc formed in this portion of the cell, and hydrogen set free. At the porous cell, however, this hydrogen meets, not with sulphate of copper, but with nitric acid. From this nitric acid the hydrogen takes part of its oxygen, with which it forms water, while the acid is by this process reduced to peroxide of nitrogen or to nitric oxide. Here, then, as before, the hydrogen is got rid of by compelling it to form a compound with some other element present in the battery.

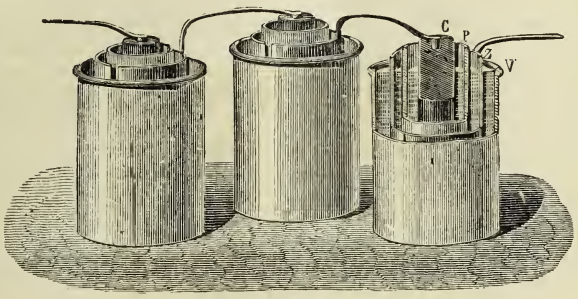


FIG. 51.—BUNSEN'S BATTERY.

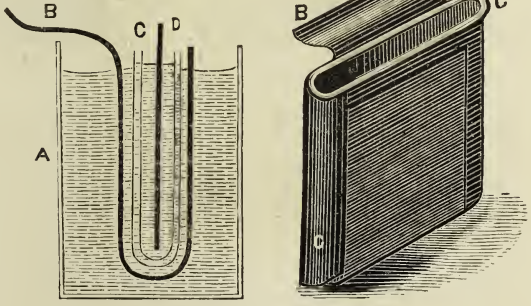


FIG. 52.—GROVE'S BATTERY.

Grove's form of battery is one of the most convenient as also one of the most powerful forms of a constant battery, but is very expensive, owing to the high price of platinum. The fumes which it gives off are also objectionable.

A form of battery frequently employed instead of that of Grove is one invented, in 1843, by Bunsen, and known by his name. It is represented above (fig. 51). Here V is the glass or porcelain cell containing dilute sulphuric acid; Z is a hollow cylinder of zinc; P is a porous cell containing strong nitric acid, in which is inserted a cylinder of gas coke, C. The connection of the cells with each other is made in the same way as with a Daniell's cell—by strips of thin copper. The theory of the mode of action of this cell is the same as that in Grove's battery described above, than which it is much cheaper.

Bunsen's battery.

It is used almost universally in France and Germany, but is more expensive to work and more clumsy to manipulate.

Beside these more common forms of constant battery, there are two or three other forms of more recent invention which deserve a passing notice.

Sulphate of mercury battery.

One of these is represented in fig. 53, and is the *sulphate of mercury* battery devised by M. Marié Davy.

Like the Bunsen battery, each cell contains a zinc hollow cylinder, Z. a porous cell, P, and a carbon cylinder, C. The outer vessel contains ordinary water or brine, and the porous cell sulphate of mercury. The sulphate of mercury is well shaken up with about three times its volume of water, in which it is with difficulty soluble. The liquid is then poured off from the sulphate, which is mainly left at the bottom of the vessel in the form of a thick paste. This thick paste is placed round the carbon cylinder so as to fill up the space between it and the porous cell, and then the solution of sulphate of mercury which was poured off is poured into the porous cell.

When this battery is set to work, the zinc decomposes the water or brine, setting free hydrogen in the usual manner. This hydrogen acts upon the sulphate of mercury and reduces it, forming sulphuric acid and metallic mercury. The latter is deposited at the bottom of the cell, and the former, passing through the porous cell, attacks the zinc, and thus increases the action.

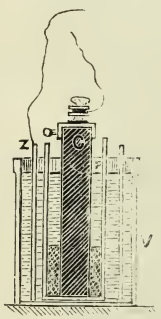


FIG. 53.—MARIE-DAVY BATTERY.

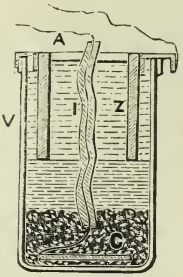


FIG. 54.—CALLAND'S BATTERY.

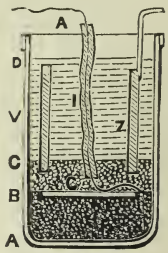


FIG. 55.—MENOTTI'S BATTERY.

From the mercury which collects at the bottom of the porous cells, a quantity of sulphate of mercury may be formed, equal to that decomposed during the action of the battery. This form of battery soon fails when used continuously, but answers very well with discontinuous work, such as that of the telegraph.

Gravitation batteries.

In all the two-fluid batteries hitherto described, a porous cell is employed to separate the two liquids; others, however, have been devised in which, owing to the difference between the specific gravities of the substances employed, no porous cell is necessary.

One of these so-called "gravity" batteries, devised by M. Calland, of Nantes, is represented in fig. 54.

Here an earthenware vessel, V, contains a copper plate, to which a wire A, insulated by gutta percha I, is soldered. Upon C a number of crystals of sulphate of copper are placed, and the cell being filled up with water, a zinc cylinder, Z, is placed in it.

When the battery commences to act, the lower part of the liquid becomes saturated with sulphate of copper, and, the action of the cell being similar to that of a Daniell's cell, sulphate of zinc is formed, which, owing to its less specific gravity, floats upon the top of the solution of sulphate of copper.

Menotti's battery.

A variation of Daniell's cell, known by the name of its inventor, Menotti, is represented in fig. 55.

Here the porous cell is replaced by a layer of sawdust or sand, B C. At the bottom of the containing cell V a layer of coarsely-powdered sulphate of copper, A, is placed, and upon this is laid a copper plate, provided, as in Calland's battery, with an insulated wire, I.

Upon the top of this is placed the sand or sawdust, and, the whole being filled up with water, a zinc cylinder, Z, completes the arrangement. The action is precisely the same as in a Daniell's cell. A great objection to the sand or sawdust is the considerable resistance it offers to the current.

A form of one-fluid battery which is coming somewhat generally into use for telegraphic purposes is that known as Leclanché's battery.

In it a rod of carbon in a porous cell is tightly packed in a vessel containing peroxide of manganese and coke mixed together. In the outer cell a zinc cylinder is placed. The liquid employed is a solution of ammoniac chloride (sal-ammoniac).

When set to work chloride of zinc is formed and hydrogen and ammonia set free. The latter escapes as a gas, while the former is oxidized by the manganese, and forms water.

Fleming's battery.

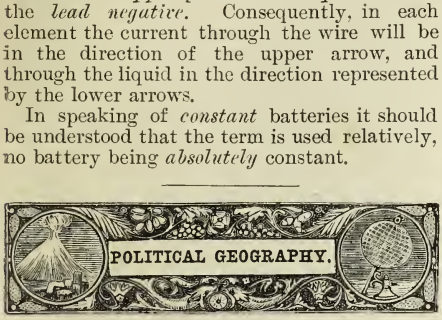
A form of battery which deserves at least a passing notice is one recently devised by Mr. Fleming, in which both poles are of the same metal. Fig. 56 (*see* Art. XVI.) represents this form of battery.

As will be seen from the letters under the cells, two liquids are employed in alternate elements, nitric acid in one cell, and pentasulphide of sodium in the next, and so on throughout the battery.

Each cell contains a plate of copper, *Cu*, and a plate of lead, *Pb*, but it will be noticed that the copper of one cell is connected with the copper of the next, and not, as would be the case in another battery, with the lead. By using an even number of elements the terminals of such a battery will both be of copper. This arrangement is a very good example of the fact previously mentioned—that a metal which, when opposed to another metal in a certain

liquid, is, say, positive, may have its polarity reversed by changing the liquid. Thus, as in the battery now under consideration, *lead* is *positive* and *copper negative* when the liquid employed is nitric acid, but in pentasulphide of sodium the *copper* plate becomes *positive* and the *lead negative*. Consequently, in each element the current through the wire will be in the direction of the upper arrow, and through the liquid in the direction represented by the lower arrows.

In speaking of *constant* batteries it should be understood that the term is used relatively, no battery being *absolutely* constant.



VII.

HOLLAND.

HOLLAND, or THE NETHERLANDS, is a kingdom of Western Europe, lying along the shores of the German Ocean between lat. 50° 44′ and 53° 34′ N., and long. 3° 30′ and 7° 10′ E., and bounded on the north and west by the German Ocean, south by Belgium, and east by Germany. It has an area of 12,586 square miles, and a population (in 1880) of 4,012,693, of whom 2,469,814 were Protestants, 1,439,137 Roman Catholics, and 81,693 Jews. The principal towns, with their populations, are Amsterdam, 326,196; Rotterdam, 152,517; The Hague, 117,856. Holland forms the western extremity of the great plain of Europe, and its surface is low and flat, with the exception of some inconsiderable hills that traverse the provinces of Gelderland, Overyssel, and Utrecht. The land has for the most part been formed of the deposits of the three principal rivers which flow through it—the Rhine, Meuse, and Scheldt. These have as far as possible been confined by embankments within narrow channels, and numerous canals have been formed to carry off the superfluous water, and to serve as means of internal communication. The land thus acquired is nowhere much above the level of the sea, and in many parts is considerably below it. Hence a great part of the coast has to be protected by enormous dykes, partly formed of huge blocks of granite brought from Norway, partly of mud and clay, with wickerwork. The rivers here divide near their mouths into various branches, forming numerous islands, the principal of which are Walcheren, North Beveland, South Beveland, Schouwen, Tholen, Over-Flakee, Voorne, and Beyerland. The great shallow gulf called the Zuyder Zee was formed in the thirteenth century by the bursting in of the sea on an inland lake. The former line of coast is marked by a chain of islands, the chief of which are Texel, Vlieland, Terschelling, Ameland, and Schiermonnikoog. The Haarlem lake, which had a circumference of thirty-three miles, has recently been drained, and its site is now occupied by cultivated fields. The climate generally is variable and very moist. In winter the rivers and canals are frequently frozen over for two or three months. The greater part of the land is in pasture, and the rearing of cattle and the making of butter and cheese are more attended to than agriculture. The principal crops are rye, barley, oats, wheat, buckwheat, potatoes, peas, beans, flax, hemp, tobacco, and madder. Apple, pear, cherry, and other fruit trees are common. The soil being almost entirely alluvial, Holland has no mineral resources. The principal manufactures are linen, cotton, woollen and silk fabrics, bricks, gin, tobacco, sugar, beer, paper, and leather. Diamond-cutting employs about 1000 hands in Amsterdam. Ship-building and the herring and other fisheries are actively carried on. At one time the foreign trade of the Netherlands exceeded that of any other European country, and it is still very large. In 1879 the total value of the imports for home consumption was £70,554,000; the exports of home produce and manufacture, £48,471,000. The imports were chiefly from Great Britain, Belgium, and Germany; the exports chiefly to Germany, Great Britain, and Belgium. More than one-fourth of the trade was with Great Britain. There entered the various ports 7820 vessels of 9,134,888 tons, and left 7620 vessels of 9,007,770 tons. The chief exports are cheese, butter, cattle, sheep, sugar, flax, gin, and madder; the imports, colonial and manufactured goods, corn, wine, cotton, wool, and coal. Besides its navigable rivers and canals, Holland possesses excellent roads and 1180 miles of railway.

The government is a constitutional representative monarchy. The executive power is vested in the king; the legislative in the king and the States-General, which is composed of two chambers, the first of 39 members elected by the provincial councils; the second of 86 members chosen by the people of the several electoral districts. By the budget of 1881 the expenditure is estimated at £10,372,244, and the revenue at £8,759,217, the national debt being £78,522,604. The permanent army on the peace footing consists of 2,334 officers and 62,779 men, besides a militia, and a colonial force of 15,788 Europeans and 18,211 natives. The navy consists of 163 steamers and 17 sailing vessels, having in all 542 guns, and manned by 5,914 men. Education is well attended to, and there are three universities—Leyden, Utrecht, and Groningen. The kingdom is divided into eleven provinces. The colonial possessions of Holland have an area of 666,000 square miles, and a population of 25,000,000, including the islands of Java, Celebes, and the Moluccas, with portions of Borneo, Sumatra, and Papua or New Guinea, in the East Indies; Surinam, or Dutch Guiana, in South America; and Curaçao, etc., in the West Indies. The king of Holland is also grand duke of the neutral territory of Luxemburg, lying between Belgium, Germany, and France, and having an area of about 1000 square miles and a population of 209,570.

BELGIUM.

BELGIUM, as an independent state, dates only from 1830, previous to which time it formed

part of the kingdom of the Netherlands. It is bounded on the north by Holland, north-west by the North Sea, south-west and south by France, and east by the Grand Duchy of Luxemburg, Rhenish Prussia, and Dutch Limburg. It is somewhat triangular in form, its greatest length from north-west to south-east being 174, and its greatest breadth from north to south 105 miles. Its area is 11,373 square miles or about one-eighth that of Great Britain, and its population (1880) 5,536,654, about one-fifth that of Great Britain. It is thus much more densely populated than Britain, and is in fact the most densely populated country of Europe, having on an average about 487 inhabitants to the square mile. It is divided into nine provinces—Antwerp, Brabant, East and West Flanders, Hainault, Liége, Limburg, Luxemburg, and Namur. The principal towns, with their populations, are Brussels, 170,345; Antwerp, 163,011; Ghent, 132,839; Liége, 121,787.

The surface is generally flat, having few elevations, and these rarely exceeding 2000 feet. They occur principally in the east and south-east, while in the north and north-west the country resembles Holland, and like it has parts of the coast protected by dykes. The principal rivers are the Scheldt and Meuse, with their tributaries, having in all a navigable length of 630 miles, in addition to which there are 376 miles of canal navigation. Length of railways 2559 miles. The climate is more temperate and salubrious than that of Holland, resembling more closely that of England, but it is somewhat colder in winter and hotter in summer. In the south-east the atmosphere is more pure and bracing than in the north-west, where it is frequently damp and hazy. About nine-tenths of the land is under cultivation, and about one-fourth of the population are employed in agriculture. The soil is fertile, and is cultivated with great care, but the holdings generally are small, more than one-half of them not exceeding two and a half acres. The principal crops are rye, wheat, oats, barley, potatoes, peas, beans, flax, hemp, beet, tobacco, chicory, hops, and madder. The rearing of cattle also receives a considerable degree of attention. Belgium is rich in various kinds of minerals, as coal, iron, lead, and zinc. As a coal-producing country it is next to England, yielding annually upwards of 15,000,000 tons. Iron is also abundant. There are likewise quarries of marble, freestone, granite, limestone, and slate. The chief manufactures are hemp, flax, linen and cotton yarn, linen, cotton and woollen stuffs, carpets, wrought iron, hardware, machinery, firearms, sugar, paper, glass, and lace. The chief imports are colonial produce, and the raw materials for cotton and woollen manufacture; the exports, coal, flax, wrought iron, machinery, woollen stuffs, yarn, sugar, hides, grain, etc. The trade is principally with France, Germany, England, Holland, the United States, and Russia. In 1879 the total imports amounted to £61,020,000; the exports to £47,616,000. The government is a constitutional hereditary monarchy. The legislative power is vested in the king, the Chamber of Representatives composed of 132 members elected for four years, and the Senate of 66 members elected for eight years. The members of both houses are elected directly by the people paying a certain amount of direct taxes. Almost all the people are Roman Catholics, except about 15,000 Protestants and 3000 Jews, but full liberty is accorded to all. Education is very generally diffused; and there are four universities. About 57 per cent. of the people are Flemings, a branch of the Teutonic family, speaking the Flemish, a branch of the Low German; and about 42 per cent. Walloons, of French extraction, and speaking Walloon, a dialect of the French. The army on the peace footing numbers 46,272, and is capable of being raised in war to 103,683 men. The revenue and expenditure for 1881 are estimated at £11,454,745 respectively, and the public debt at £70,393,458.

DENMARK.

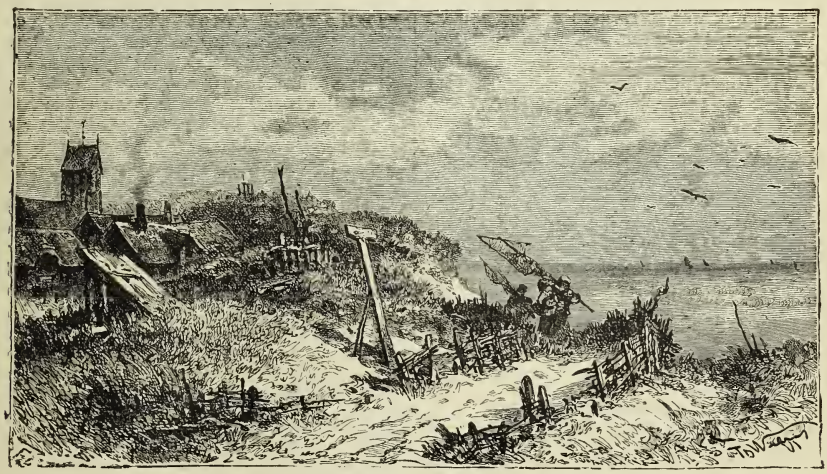
THE kingdom of Denmark comprises the northern portion of the peninsula of Jutland, and the neighbouring islands of Fünen, Zealand, Laaland, etc. It lies between lat. 54° 34′ and 57° 44′ N. and long 8° 5′ and 12° 40′ E., and is bounded, north by the Skager Rack, west by the North Sea, south by Prussia and the Baltic, and east by the Baltic, the Sound, and the Cattegat. Area 14,784 square miles, and population (1880) 1,969,039. By the Dano-German war Denmark lost the duchies of Schleswig, Holstein, and Lauenburg, having an area of 6910 square miles, and a population (1880), of 1,124,862. Denmark also possesses the Faröe Islands, Iceland, Danish Greenland, and the West India Islands of Santa Cruz, St. Thomas, and St. John, having together a population of 130,350.

The country forms part of the great plain of Europe, and is low and flat, none of its elevations much exceeding 500 feet above the sea. Jutland forms about two-thirds of the entire area. A considerable part of the surface in the west and centre is occupied by bare sandy heaths, while in the east are fertile corn-lands interspersed with woods. The largest of the islands is Zealand, which has an area of 2,700 square miles, and is separated from Sweden by the Sound, and from Fünen by the Great Belt, while the Little Belt separates Fünen from Jutland. Zealand is well cultivated and fertile, and has on its east coast the capital, Copenhagen. Fünen, the next in size, has an area of 1270 square miles, and Laaland 450. At some distance from the others is the island of Bornholm, in the Baltic, which has an area of 220 square miles. There are no considerable rivers, but numerous small streams, and a great many lakes. The climate resembles that of Scotland, but is more humid, and the extremes of heat and cold are usually greater. Agriculture is extensively carried on, and affords employment to the greater part of the population. The principal crops are oats, barley, rye, wheat, peas, beans, potatoes, rape-seed, hemp, flax, hops, and tobacco. The rearing of horses, cattle, and sheep also receives great attention, particularly in Jutland. The fisheries are

actively carried on along the coasts. The mineral resources are inconsiderable, except in the island of Bornholm, where an inferior kind of coal is found, and porcelain and other clays. Peat is everywhere abundant. The manufactures are unimportant, consisting chiefly of linen and woollen articles for domestic use, earthenware, beer, brandy, glass, leather, paper, sugar, and tobacco. The chief articles of export are grain, cattle, butter, cheese, horses, brandy, beer, hides, and fish; of import sugar, coffee, tea, wine, salt, cotton, wool, coals, timber, and iron. In 1879 the total imports amounted to £10,782,000, and the exports to 8,562,000, about one-fourth of the former and three-fifths of the latter being with England. There are 988 miles of railway in operation.

The government was formerly an absolute monarchy, but the people are now represented in a Diet or *Rigsdag*, composed of two chambers—a *Landsthing* or upper house, and a *Folksthing* or house of commons. The former consists of 66 members, 12 of whom are nominated for life by the king, the others elected for eight years by the various districts; the latter of one representative for every 16,000 inhabitants—102 in all—chosen directly by the people for three years.

In 1880 the revenue amounted to £2,574,094, the expenditure to £2,392,575, and the public debt to £9,629,000. The inhabitants belong to the Scandinavian branch of the Teutonic race, and speak the Danish language, a form of the old Norse. They are almost all Lutherans, with the exception of about 3000 Roman Catholics and 4000 Jews. Education is national and compulsory, and there is a university at Copenhagen. Personal military service is obligatory on all males, commencing at twenty-two years of age, and lasting for sixteen years. The army and reserve comprise 1470 officers and 49,780 men. The navy consists of 33 steam vessels of 30,527 horse power, with 245 guns and 1122 men. The chief town, Copenhagen, has 234,850 inhabitants.



SCENE ON THE DUNES.

ARITHMETIC.

XLI.

Equation of Payments.

When several sums of money are due each at different times, and it is desired to pay them all off at one time, so that neither debtor nor creditor may suffer any loss of interest, the time for paying them off must evidently be so chosen that the interest for that time on the sum of the debts shall be equal to the sum of the interests on the several debts for their respective times. For example, if, instead of paying a debt of £100 3 months hence, and another debt of £100 9 months hence, I wish to pay the £200 at one time, I ought to do so 6 months hence. For by so doing I gain the interest on the first £100 for 3 months, but I lose an equal amount of interest on the second £100, and thus the interest on the united debts (namely, £200) for 6 months is the same as the sum of the interest on £100 for 3 months, and £100 for 9 months.

The time at which the united debts can be paid off together is called *the equated time*.

We shall best see our way to a rule by taking an example:—Find the equated time at which I can pay together two debts, one of £200, due 3 months hence, and the other of £800, due 10 months hence.

The united debts amount to £1000, and the question is in what time will the interest on £1000 amount to the same as the interest on £200 for 3 months, together with the interest on £800 for 10 months? Now,

Int. on £200 for 3 mths. = int. on £600 for 1 mth.;
„ £800 „ 10 „ = „ £8000 „ 1 „
∴ the sum of the int. = „ £8600 „ 1 „

The question is now in what time will £1000 produce the same amount of interest as £8600 produces in one month? Which gives us the following statement :—

£1000 : £8600 : : 1 month : required number of months.

Ans. $= \frac{8600}{1000} = 8\frac{3}{5}$ months.

The above process is equivalent to the following rule. To find the equated time :—Multiply each debt by the time it has to run, add the products, and divide the sum so found by the sum of the debts. The quotient is the equated time.

In finding the equated time we have hitherto considered only mercantile discount. A slight change in the rule will be necessary if we reckon true discount. The rule in this case will be:—Multiply the *present worth* of each debt by the corresponding time, and divide the sum of the products so found by the sum of the present worths.

Example.—Find equated time of £312, due 8 months hence, and £212, due a year hence, at 6 per cent. per annum. The true present worth of

£312, due 8 months hence, = £300.
£212 „ a year hence = £200.

Hence by the rule,

$$\text{Equated time} = \frac{300 \times 8 + 200 \times 12}{300 + 200} \text{ months.}$$

$$= \frac{4800}{500} = 9\frac{3}{5} \text{ months.}$$

It will be observed that the rate of interest is immaterial when we reckon mercantile discount, but *is* material when we reckon true discount, as we must in that case calculate the true present worth, which of course depends on the rate of interest. Care must be taken to express the several times in one and the same denomination.

Stocks, Shares, etc.

The English and most other modern governments have, for the purpose of meeting extraordinary demands on the national purse, borrowed at various times large sums of money from all who were willing to lend it. When we say that they borrowed the money, this is not always strictly accurate, because they do not generally undertake to repay it. They only undertake to pay interest at a given rate on the money thus raised, so long as it remains unrepaid; but they reserve to themselves the right to repay the original sums if they see fit to do so. Of course the original lenders may sell or give to any one they please, and for any price they can get, their right to the annual interest, and the buyer stands in the place of the original lender. The money lent to the government on these conditions is called Stock. The money annually raised by taxes to make a fund for paying the annual interest on the stock is properly called the Funds, but now the stock itself is often called the funds. Thus suppose *A* had originally lent £1000 to the government on the above conditions, he would be said to be the owner of £1000 of stock, or to have £1000 in the funds; and he would get the fixed interest originally agreed on—say 3 per cent., or £30 for his £1000. Now, suppose he wanted his money he could not get it from the government, but a stockbroker would probably be able to find him some one who wished to buy his claim against the government, and would give him a fair price for it. The buyer would then have his name put down as the owner of £1000 of stock, and the government would regularly pay him £30 a year. "The price of stock" at any time is the price for which £100 of stock can at that time be got in the market.

Thus, when it is said that the price of 3 per cent. stock is 91, or that the 3 per cent. funds are at 91, the meaning is that £100 of stock can be bought in the market for £91. In other words, that for £91 I can buy the right to receive from the government £3 per annum for ever.

Since the interest on £100 of stock remains always the same, while the interest which can be got by other investments is constantly varying, it is clear that the price of stock will rise or fall according as the interest which can be got by other means falls or rises. Thus, if after I have bought £100 of stock at the price of £91, I find that the rate of interest is going up in the market, I think I can get more than £3 for my £91, and so I wish to sell my stock. But the same motive which induces me to sell keeps others from buying, and so I probably cannot get as much as £91 for my stock, and am glad perhaps to sell it for £89 or less. If, on the contrary, the rate of interest in the market had fallen considerably, I should be very glad to get £3 for my £91, and others would be very glad to buy my stock, and so if I wanted to sell at all I should demand more than £91.

When the price of £100 of stock is £100, the stock is then said to be "at par"; when below £100 it is said to be "at a discount," and when above £100, "at a premium."

Different kinds of stock go by different names : *e.g.*, *Consols*, an abbreviation of consolidated annuities, are so called because several different stocks were consolidated into one, at the rate of 3 per cent. "Reduced annuities," and "new 3 per cent. annuities," are the most important of the other 3 per cent. stock, and get their names from the circumstances of their creation. The whole amount of stock on which our government at present pay interest is over 700 millions, the result chiefly of borrowings to defray the expenses of former wars.

Government stock is bought or sold through a broker, who charges a commission of $\frac{1}{8}$ per cent. (*i.e.* 2*s.* 6*d.* per £100) on what is bought or sold. Thus the buyer of stock at £91 has to pay £91 2*s.* 6*d.*, and the seller of the same receives only £90 17*s.* 6*d.*

We have hitherto spoken only of government stocks. But there are some public companies, such as the Bank of England, the East India Company, railway companies, etc., whose capital is also called stock, and is subject to similar conditions.

Shares in companies are also similar, but they are generally subject to more complicated conditions, and their value is liable to much

greater variations, the interest on ordinary shares not being a fixed amount, but depending on the profits of the concern.

Examples. Questions in stocks, shares, etc., are all done by the rules of proportion. We shall show how to deal with them by a few examples.

1. When 3 per cent. consols are at $90\frac{1}{4}$, find (*a*) what income will be derived from £7500 consols, and (*b*) what is the selling price of that amount of stock.

(*a*) Every £100 of stock gives an income of £3 ∴ £100 : £7500 :: £3 : required income.

(*b*) The selling price of £100 of stock is $90\frac{1}{4}$.

∴ 100 : 7500 :: $90\frac{1}{4}$: selling price.

2. What sum must I invest in the $3\frac{1}{2}$ per cent. stocks at $93\frac{1}{8}$, so as to produce an income of £1000 yearly?

I must invest £$93\frac{1}{8}$ to get an income of £$3\frac{1}{2}$.

∴ $3\frac{1}{2}$: 1000 :: $93\frac{1}{8}$: required sum.

To find the sum required for the investment and to defray broker's charge, we have the following statement :—

$3\frac{1}{2}$: 1000 :: $93\frac{1}{4}$: required sum.

3. If I invest £1000 in the consols when they are at 90, and sell out at 92, what do I gain by the transaction after paying broker's charges?

I pay £$90\frac{1}{8}$ and receive £$91\frac{7}{8}$, ∴ I gain £$1\frac{3}{4}$ on every £$90\frac{1}{8}$.

∴ $90\frac{1}{8}$: 1000 :: $1\frac{3}{4}$: nett gain.

4. What rate per cent. do I obtain for money invested in consols when they are at $93\frac{7}{8}$?

Here £$93\frac{7}{8}$ produces £3 per annum.

∴ $93\frac{7}{8}$: 100 :: 3 : rate per cent.

5. How much $3\frac{1}{2}$ per cent. stock at 95 must be sold to realize £1000?

Here £100 of stock must be sold to realize £95.

∴ 95 : 100 :: 1000 : stock to be sold.

6. Which is the better stock to invest in—the $3\frac{1}{2}$ per cent. at 90 or the 3 per cent. at 88?

In the first stock, I get £$3\frac{1}{2}$ for every £90 ; ∴ for £1 I get £ $\frac{3\frac{1}{2}}{90}$ or £$_{1}\frac{7}{8}{}_{0}$.

In the second, I get £3 for every 88 ; ∴ for £1 I get £$\frac{3}{88}$.

If we compare these fractions we find that the former is the larger (∵ 7 × 88 is greater than 3 × 180) ; ∴ the former stock yields the larger income.

Exercises in Stocks.

1. A person buys £1000 worth of stock at $98\frac{3}{4}$, and sells it again at such a price that he gains £42 10*s.* by the transaction. At what rate did he sell?

2. When the $3\frac{1}{2}$ per cents. are at 75, how much of them can be bought for £285?

3. How much money will be required to buy £800 of 4 per cent. stock at 89?

4. I buy £5050 of stock when it is $85\frac{3}{8}$: what sum do I invest?

5. What is the money value of £1500 of stock the selling price of which is $92\frac{1}{2}$?

6. What is the income arising from £1000 invested in the 3 per cents. at $88\frac{1}{2}$?

7. What sum must be invested in the $3\frac{1}{2}$ per cents. at 90 to produce an income of £35 yearly?

8. A person invests £94 in the $3\frac{1}{2}$ per cents. when they are at 94 ; how much does he receive annually from this investment?

9. What is the income arising from £1000, $\frac{3}{5}$ of which is invested in $3\frac{1}{2}$ per cents. at par, and the remainder in 3 per cents. at 98.

10. £5000 of 4 per cent. stock is transferred at 90 into 3 per cents. at 72. What is the difference between the new income and the old?

Answers.

1. 103 ; 2. £380 ; 3. £712 ; 4. £4311 8*s.* 9*d.* ; 5. £1387 10*s.* ; 6. £33 17*s.* $11\frac{3}{59}$*d.* ; 7. £900 ; 8. £3 14*s.* $5\frac{2}{47}$*d.* ; 9. £33 4*s.* $10\frac{3}{49}$*d.* ; 10. £12 10*s.*

XXXIX.

Brewing and Distilling.

The first step in the manufacture of beer consists in the conversion of a portion of the starch of some grain—generally barley—into sugar by the action of diastase. The barley is first moistened and allowed to undergo germination up to a certain point; when this is reached, that is to say when the grain has just begun to sprout, further growth is checked by drying it in an oven or kiln at a temperature of about 150°. The barley has now been converted into malt, as it is termed, the degree of drying or roasting to which it is subjected varying for different kinds of beer. The amount of sugar present in malt will be found to be greatly in excess of that which originally existed in the barley; a portion of the starch has also been converted into gum or dextrine.

Manufacture of malt.

Different kinds of malt.

Changes effected by malting.

We have already drawn attention to the fact that the action of that singular natural compound termed diastase is similar to that of sulphuric acid in the conversion of starch into sugar. The mere presence of either body is sufficient, while neither appears to suffer any decomposition. Such action is termed catalytic, and is very rapid, as may be exemplified in the following manner: If to a thick viscid solution of starch we add about a tablespoonful of strong infusion of malt, keeping the temperature up to 160° Farenheit, a change soon becomes apparent. The whole mass assumes a liquid condition, owing to the formation of dextrine. At first there is no sweetness ; this, however, soon follows, and in the course of a few hours abundance of sugar will have been formed. When in this experiment we begin with a determinate weight of starch we shall find that of the sugar produced somewhat in excess of it. This may

Action of diastase.

Conversion of starch into sugar by diastase in malt.

Dextrine formed before sugar.

Weight of sugar in excess of that of starch.

be explained by the fact that the glucose or sugar contains a larger proportion of the elements of water than the former. Thus, theoretically we may say that starch becomes sugar by taking up a portion of the elements of water. Dextrine and starch, on the other hand, may be termed allotropic bodies, as their composition is identical.

Composition of sugar dextrine and starch.

The infusion or solution of malt is known to the brewer under the name of wort. The process by which it is obtained is termed mashing, and the vessel used for the purpose a mash-tub. During the mashing the unchanged starch of the malt is gradually converted into sugar, so that the wort becomes sweeter as the operation progresses. Much practical skill is required in conducting this operation, and the temperature at which the several mashings are effected must be such as to exhaust or extract all the virtue in the malt.

Wort.

Mash-tub.

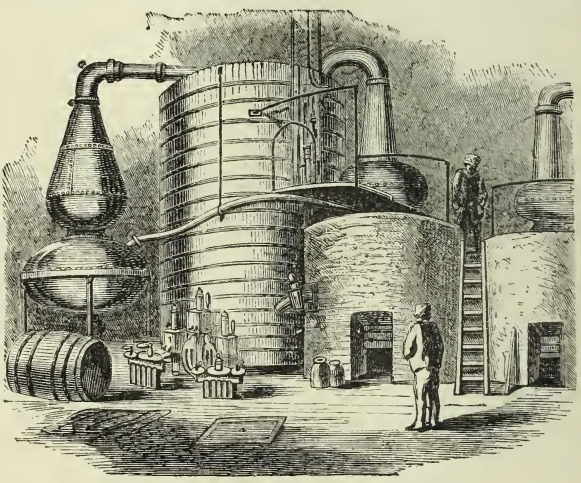
Brewers' grains.

The residue, consisting of the insoluble portion of the malt, is termed brewers' grains, and is used in feeding cattle.

The quantity of wort obtainable from a given quantity of malt will depend upon the nature of the beer we intend to brew, its strength being determined by its specific gravity, which is ascertained by a hydrometer — an instrument for testing the density of a liquid—generally known among brewers, however, by the term saccharometer.

Specific gravity of wort.

Saccharometer.



STILLS.

The next process in brewing consists in boiling the wort with the hops, which communicate the pleasant aromatic bitter so much relished in beer. Hops were first introduced into this country from Flanders, in the reign of Henry VIII. They are now extensively cultivated in England, and the appearance of the plant and the fragrant odour of the flower or bine are doubtless well known to all. The active constituents of the hop consist of an essential oil, bitter extractive, and a small portion of gum or resin. A very important part of the preparation of the hops for use in brewing consists in the manner of drying them. This is performed in a kind of kiln known throughout Kent and Sussex as an oast-house. The final process consists in fumigation with sulphurous acid, the object of which is so to bleach the hop as to prevent it communicating an uninviting tint to the beer. Hops are packed in large bags, technically known as pockets, and are subject to considerable pressure so as to exclude the air.

Addition of hops to beer.

The flavour of the hop.

Drying the bine of the hop.

Bleaching process.

The relative proportion of the hop to the malt in beer varies with the quality and character of the beverage: about one-twentieth may, however, be taken as the average. In addition to the aromatic bitter and tone they communicate, they tend to diminish the tendency to secondary fermentation, and prevent the beer deteriorating in quality. As these virtues reside in the essential oil of the hop, care should be taken not to allow the aroma to be dissipated by the steam escaping from the boiling coppers, which should be constructed with a view to prevent this.

Proportion of hops in beer.

Uses of the hop.

Preservation of the aroma.

No substitute has yet been found for the hop in beer. Quassia, chamomile, gentian, and other bitters have been employed; but they are all inferior to the hop, leaving a permanent and not very pleasant bitter flavour on the palate.

Substitutes for the hop.

The contents of the brewing copper—that is, the decoction of the hops in the wort—is allowed to run off through a strainer, and cooled down to 60° or even lower. This operation, a very important one in brewing, is conducted in shallow vessels placed in an airy situation and subject to currents of air, raised in some cases artificially by fanning machinery. The cooling process is also sometimes effected by causing the hopped wort to flow through metal pipes cooled by streams of water playing upon them.

Cooling the hopped wort.

By air and by water.

When sufficiently cooled the liquor is drawn off into the fermenting vats or gyle-tuns, yeast being added to promote the fermentation, which generally comes on in six or eight hours. A thick scum or foam gradually collects upon the surface of the liquid, its temperature rises, and carbonic acid escapes in increasing quantities. At length the evolution of the gas ceases, the liquor becomes quiet and clear, is less sweet, of diminished density, and has become intoxi-

Fermentation of beer in vat.

cating owing to the formation of alcohol. A large proportion of saccharine constituents of the wort have, in point of fact, been converted into carbonic acid and alcohol. The process is now complete: the beer is drawn off into casks, and is ready for use. The dark colour of porter and stout is communicated by the caramel of burnt sugar formed in the malt by roasting. Molasses and liquorice are sometimes, however, improperly substituted for the caramel.

Completion of process.

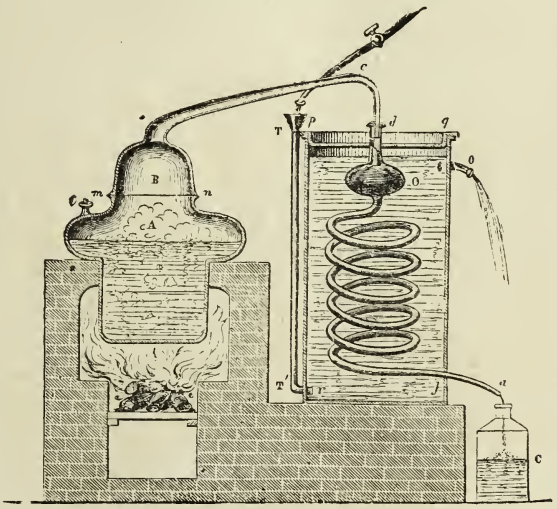
Colour of porter and stout.

When the object in view is not the production of beer but of ardent spirits, the wort, or wash as it is termed in distilleries, is not obtained from malt alone, but from raw or unroasted grain, a small proportion only of malted grain being used, the diastase of which is sufficient to convert a large proportion of starch into glucose or fermentable sugar. The wash is brought to a ferment as quickly as possible by the addition of yeast, and the alcohol thus developed is separated from the wash in a more or less pure state by distillation. Whisky is distilled from barley and oats; and the fact that much of the malt used in making whisky is peat-dried doubtless communicates the smoky taste so characteristic of certain kinds of whisky. Brandy, a word derived from the German, and signifying burnt wine, is distilled from wine. Rum, as already mentioned, is prepared from molasses, the uncrystallizable portion of cane sugar—the first step in the preparation of this spirit being the conversion of the cane sugar into glucose. Gin and Hollands are distilled from barley, the former being generally reputed to be flavoured with juniper berries. In the East a spirit known as arrack is prepared from rice, a grain containing a larger amount of starch than any other.

Manufacture of spirits.

Nature of the wash.

Spirits distilled from the wash.



BRANDY-STILL.

A, Copper still; B, Head; C, Receiver; T T, Funnel-tube.
b c d, Bent tube; *p q r j*, Metal cylinder; *a*, Worm; *t*, Tubulure; *o*, Tube for escape and heated water.

Their manufacture.

It has long been known that natural juices susceptible of undergoing vinous fermentation were also subject to another change, by which they lose their intoxicating properties and become sour to the taste—in other words, are converted into vinegar. This process is sometimes spoken of as acetous fermentation, although in truth it has nothing in common with vinous fermentation. It consists in the conversion of the alcohol of the beer or wine into acetic acid—a compound whose constituents are the same as those of alcohol, with the exception that the proportion of the oxygen to the hydrogen and the carbon is much greater in vinegar than in alcohol. In the formation of vinegar it is absolutely necessary that the liquor should be exposed to the influence of the atmosphere, as it is by its direct action that the oxidation of the alcohol is effected.

Formation of vinegar.

Conversion of alcohol into acetic acid.

Result of oxidation.

The best vinegar is made from wine; only inferior wines, however, are employed for the purpose. The wine intended to be converted into vinegar is exposed to the air in casks containing a certain portion of the crushed husks of skins of grapes. From time to time the liquor is drawn off below, air supplies its place; the husks of grape absorb oxygen, which they yield to the alcohol of the liquor when it is poured back into the vessel. This process is continued until the alcohol is converted into acetic acid—in other words, until the liquor has been converted into vinegar. Free access of air, a temperature not below 75°, and the exposure of a considerable surface to the action of the atmosphere, are the chief essentials in the manufacture of vinegar.

Conversion of wine into vinegar.

Vinegar may also be formed by allowing a mixture of spirits, water and yeast, or honey, to drop continuously through a perforated cask filled with beech-wood shavings moistened with vinegar. The temperature gradually rises, and the whole of the spirit after the liquor has been allowed to percolate the mass of shavings two or three times, is converted into acetic acid or vinegar. The object in this process is to expose as large a surface as possible to the action of the atmosphere, which is effected by allowing the liquor to drain gradually through the shavings, air being admitted through the perforations in the cask.

Other methods of manufacture.

In our next article we shall speak first of the infusion of tea and coffee and of the boiling of meat—subjects of every-day importance—and then we shall go on to discuss the process of tanning.

XLII.

EXERCISE ON THE FOREGOING STUDY (*p.* 442).

For translation into German, to be corrected by the German version appended.

(N.B.—It will be found good practice to get a friend to read the English exercise, sentence by sentence, and to give the German of it, verbally. The friend can then verify the correctness of the answers given by reference to the German version given below. This will be found to give readiness in conversation.)

The bird of Paradise is one of the most beautiful of all. He has a splendid plumage, which is distinguished (distinguishes itself) by the most brilliant colours. He lives in New Guinea, and loves the fruits of the teak trees. The throat of the bird of Paradise shines like emerald and gold, the feathers on the forehead are short and silky, the beak is about as long as the head, with a groove beside the point; the tail consists of twelve feathers; two of these often prolong themselves in wire form. The females have not the splendid plumage; they have also not the lengthened feathers. Various fables were in old times interwoven in the story of the birds of Paradise. As their skins often came without feet and sometimes without wings to Europe, the opinion arose that the birds of Paradise had no feet, that they continually hovered in the air, and even hatched (ausbrüten) their eggs in their (the) flight. The Europeans long placed a high value on these birds, and the natives surrounded the birds with new mysteries, because they found this proceeding (Verfahren) useful.

German Version of the above.

Der Paradiesvogel ist einer der
dare pah-ra-deece'-foh-gel ist i'-ner dare
allerschönsten. Er hat ein prachtvolles
al'-ler-schön'-sten airr hat ine pracht'-fol-les
Gefieder welches sich durch die glän-
ge-fee'-der vel'-ches sich doorch dee glen'-
zendsten Farben auszeichnet. Er
tsend-sten farr'-ben owss'-tsiche-net airr
lebt in Neu-Guinea, und liebt die Früchte
laypt in noy-gee'-ne-a unt leept dee früch'-te
der Teak-bäume. Die Kehle des Para-
dare te'-ak-boy'-me dee kay'-le des pah-ra-
diesvogels glänzt wie Smaragd und
deece'-foh-gels glentst vee smah-rahgd unt
Gold; die Federn auf der Stirne sind
golt dee fay'-dern owff dare steer'-ne zint
kurz und seidenartig. Der Schnabel
koorts unt zy'-den-ahr'-tich dare shnah'-bel
ist ungefähr so lang als der Kopf, mit
ist un-ge-fair zo lang als dare kopf' mit
einem Ausschnitt neben der Spitze; der
i'-nem ows'-shnitt nay'-ben dare spit'-se dare
Schwanz besteht aus zwölf Federn; zwei
shvants be-stayt' owss tsvölf fay'-dern tsvi
von diesen verlängern sich oft drahtförmig.
fon dee'-zen fer-lang'-ern sich offt draht'-form-ich
Die Weibchen haben nicht das
dee vibe'-chen hah'-ben nicht dass
prachtvolle Gefieder; sie haben auch
pracht'-vol-le ge-fee'-der zee hah'-ben owch
nicht die verlängerten Federn. Verschie-
nicht dee fer-leng'-er-ten fay'-dern fer-shee'-
dene Fabeln wurden in alten Zeiten
de-ne fah'-beln voor'-den in al'-ten tsy'-ten
in die Geschichte der Paradiesvögel
in dee ge-shich'-te dare pah-ra-deece'-föh-gel
eingewoben. Da ihre Bälge ohne Füße
ine'-ge-vo-ben da ee'-re bel'-ge oh'-ne füss'-e
und manchmal ohne Flügel nach Europa
unt manch'-mal oh'-ne flue'-gel nach oi-ro'-pah
kamen, entstand die Meinung daß die
kah'-men ent-stand dee my'-nung dass dee
Paradiesvögel keine Füße hätten, daß
pah-ra-deece'-föh-gel ky'-ne füss'-e het'-ten dass
sie beständig in der Luft schwebten, und
zee be-sten'-dich in dare luft schvaib'-ten unt
selbst ihre Eier auf der Flucht ausbrü-
zelbst ee'-re ey'-err owf dare flucht owss'-brü-
teten. Die Europäer legten lange
te-ten dee oi'-ro-pay'-err laych'-ten lang'-e
einen hohen Werth auf diese Vögel, und
i'-nen hoh'-en vairt owf dee'-ze föh-gel unt
die Eingebornen umhüllten die Vögel
dee ine'-ge-bor-nen um-hüll'-ten dee föh'-gel
mit neuen Mysterien, weil sie dieses
mit noy'-en mis-ta'-re-en vile zee dee'-zes
Verfahren nützlich fanden.
fer-fah'-ren nütz'-lich fand'-en

CONJUGATION OF THE REGULAR VERB.

As in the English regular verbs, the past (imperfect) tense in the indicative, and the past participle, end in *ed* (to live, I lived, p. part. lived); so in German these parts of the verb respectively end in *te*, and *t* with the prefix *ge*. Thus lieben, to love (imperfect Ich liebte, I loved. past part. geliebt, loved; drehen, to turn; Ich drehte, I turned (past part. gedreht, turned). Transitive verbs (from the Latin *transire*, to go over) are those in which the action passes to an object—as, I love my friend, Ich liebe meinen Freund; I turn the wheel, Ich drehe das Rad: these verbs form their perfect and pluperfect tenses with the auxiliary haben. The conjugation of the regular verb in German runs parallel with the verb haben, in the active voice, in the various tenses—thus, Ich werde haben, I shall have; Ich werde lieben, I shall love; Ich werde gehabt haben, I shall have had; Ich werde gelehrt haben, I shall have taught. The letter *y* found in the Old English, at the beginning of many past participles, is a relic of the German prefix *ge;* and in the Old English the ending *en* of the German infinitive is also often found. Thus Chaucer, in the "Squiere's Tale." has, "he cannot climben over so high a stile," "he could him not amenden"; and "an apparence ymade (gemacht) by some magike," and "they had yknowen it."

The passive voice of the regular verb is also conjugated, like haben, with the assistance of

the auxiliary werden: Ich werde gekauft, I am bought; Er wird gelobt werden, he will be praised, etc.

The following terminations are to be remembered in conjugating the regular verb:

Infinitive mood—EN, lieb-en, dreh-en, lob-en, to love, to turn, to praise.

Present participle—END, lieb-end, dreh-end, lob-end, loving, etc., the German end corresponding to the English *ing*.

Past participle GE—T, as ge-liebt, ge-dreht, ge-lobt, loved, etc.

In the present and imperfect tenses the different persons end thus:

Present.

	INDIC.	SUBJUNC.
Singular.		
1st person (I)	e	(Ich) e
2nd person (thou)	eſt, or ſt	(du) eſt
3rd person (he, etc.)	et, or t	(er, etc.) e
Plural.		
1st person (we)	en	(wir) en
2nd person (you)	et, or t	(ihr) et
3rd person (they)	en	(ſie) en

Imperfect.

	INDIC.	SUBJUNC.
Singular.		
1st person (I)	ete, or te	(Ich) ete
2nd person (thou)	eteſt, or teſt	(du) eteſt
3rd person (he, etc.)	ete, or te	(er) ete
Plural.		
1st person (we)	eten, or ten	(wir) eten
2nd person (you)	etet, or tet	(ihr) etet
3rd person (they)	eten, or ten	(ſie) eten

N.B.—The shortened form ſt and t, in the present, and te, teſt, te, in the imperfect, is almost always used in prose, in those words where the t can be pronounced after the preceding consonant: thus Ich liebte (Ich liebete would only be used in poetry); but in gründen, to found, we cannot say Ich gründ-te, but must use the full form gründete, for euphony.

In the imperative singular, the second and third persons singular are formed like the first person of the indicative present, by omitting the n from the infinitive—lobe (du), praise (thou); lobe er, praise he, let him praise; the plural is like that of the present indicative.

Model of a Regular Transitive Verb.

Active Voice.

Loben, to praise.
loab'-en

Principal parts: Infin. loben, pres. ind. lobe, *loab'-en* *loa'-be*; impf. lobte, p. part. gelobt. *loab'-te* *ge-loabt'*

Indicative.

Present.	*Imperfect.*
Ich lobe, I praise	Ich lobte, I praised
ich loa'-be	*ich loab'-te*
Du lobſt, thou praisest	Du lobteſt, thou praisedst
Er lobt, he praises	Er lobte, he praised
Wir loben, we praise	Wir lobten, we praised
Ihr lobt, ye praise	Ihr lobtet, ye praised
Sie loben, they praised	Sie lobten, they praised

Subjunctive.

Present.

Ich lobe, I may praise, or that I praise
ich loa'-be [praisest
Du lobeſt, thou mayst praise, that thou
Er lobe, he may praise, that he praise.
Wir loben, we may praise, that we praise
Ihr lobet, ye may praise, that ye praise
Sie loben, they may praise, that they praise.

Imperfect.

Ich lobete, I might praise, or that I praised
ich lo'-be-te [thou praisedst
Du lobeteſt, thou mightest praise, or that
Er lobete, he might praise, or that he praised
Wir lobeten, we might praise, or that we [praised
Ihr lobetet, ye might praise, or that ye
Sie lobeten, they might praise, or that they [praised

Perfect.

Ich habe gelobt, I have praised, etc. (Ind.)
ich hah'-be ge-loabt'
Ich habe gelobt, I may have praised, etc. (Subj.)
ich hah'-be ge-loabt'
(For second person, etc., see the verb haben.)

Pluperfect.

Ich hatte gelobt, I had praised, etc. (Ind.)
ich hat'-te ge-loabt'
Ich hätte gelobt, I might have praised, etc.
ich hat'-te ge-loabt'

First Future.

Ich werde loben, I shall praise, etc. (Ind.)
ich vairr'-de loab'-en
Ich werde loben, [that] I shall praise, etc. (Subj.)
ich vair-de loa'-ben

Second Future.

Ich werde gelobt haben, I shall have praised, etc,
ich vair'-de ge-loabt' hah'-ben
Ich werde gelobt haben, I shall have praised, etc.
ich vair'-de ge-loabt hah'-ben

First Conditional.

Ich würde loben, I should praise.
ich vuerr'-de loab'en

Second Conditional.

Ich würde gelobt haben, I should have praised
ich vuerr'-de ge-loabt' hah'-ben

Imperative.

Lobe (du), praise (thou).
loa'-be doo
Lobe er, let him praise.
Loben wir, let us praise.
Lobet (ihr), praise (ye).
Loben ſie, let them praise.

Infinitive.

Pres. Loben, to praise.
loab'-en

Perf. Gelobt haben, to have praised.
ge-loabt hah'-ben

Fut. Loben werden, to be about to praise.
loab'-en vairr'-den

Participles.

Pres. Lobend, praising. *Past.* Gelobt, praised.

(For the other persons of the various tenses refer, if necessary, to the verb haben.)

The Passive Voice.

INDICATIVE.

Present.

Ich werde gelobt, I am praised, etc.
ich vairr'-de ge-loabt'

SUBJUNCTIVE.

Ich werde gelobt, I may be praised, etc.
ich vairr'-de ge-loabt'

Imperfect.

Ich wurde gelobt, I was praised.
Ich würde gelobt, I might be praised.

Perfect.

Ich bin gelobt worden, I have been praised.
ich bin ge-loabt' vorr'-den

Ich ſey gelobt worden, I may have been
ich zy ge-loabt' vorr'-den [praised

Pluperfect.

Ich war gelobt worden, I had been praised.
ich vahr ge-loabt vorr'-den

Ich wäre gelobt worden, I might have
ich vair'-re ge'-loabt vorr'-den [been praised.

First Future.

Ich werde gelobt werden, I shall be
ich vairr'-de ge-loabt vairr'-den [praised.

Ich werde gelobt werden, [That] I shall
ich vairr'-de ge-loabt vairr'-den [be praised.

Second Future.

Ich werde gelobt worden ſeyn, I shall
ich vairr'-de ge-loabt vorr'-den zyne
[have been praised.

Ich werde gelobt worden ſeyn, I shall
ich vairr'-de ge'-loabt vorr'-den zyne
[have been praised.

First Conditional.

Ich würde gelobt werden, I should be
ich vuerr'-de ge-loabt vairr'-den [praised.

Second Conditional.

Ich würde gelobt worden ſeyn, I should
ich vuerr'-de ge-loabt vorr'-den zyne
[have been praised.

IMPERATIVE.

Werde (du) gelobt, be (thou) praised.
Werde er gelobt, let him be praised.
Werden wir gelobt, let us be praised.
Werdet (ihr) gelobt, be (ye) praised.
Werden ſie gelobt, let them be praised.

INFINITIVE.

Pres. Gelobe werden, to be praised.
Perf. Gelobt worden ſeyn, to have been praised.
Fut. Werden gelobt werden, to be about to be praised.

Participle.

Gelobt, praised.

The passive voice of any regular transitive verb can thus be formed with the various tenses of the auxiliary of tense werden. Remember that the past participle of werden, *the auxiliary* werden, to be, is worden, while geworden is the participle of the neuter verb *to become.*

XXXVII.

GREECE (*continued*).—THE PERSIAN WARS.

SOON after the Persians had retired in disgrace from Greece, war broke out between Athens and the little island of Ægina, situated about twelve miles off the coast of Attica. The war was important because to carry it on the Athenians were compelled to build a navy, which, as we shall presently see, did splendid service against the Persians in their next and final invasion.

The influence of Themistokles was also directed to making Athens a maritime state. This extraordinary man and his rival Aristides were the two most important men in Attica after Miltiades' disgrace. They were of very dissimilar character. Themistokles is considered by historians to have been one of the very greatest statesmen that ever lived in any country. His power of forecasting political events, and of devising the best means to meet them and turn them to advantage, have hardly ever been equalled. **Themistokles.**

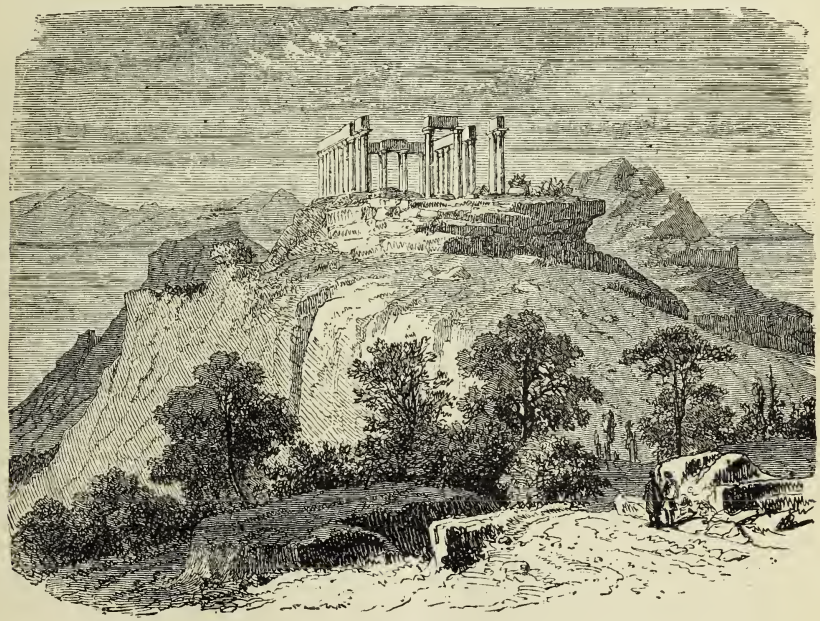
But he was dishonest, and could not resist a bribe, and he died in exile—the penalty of treachery to his country

Aristides had not one-half his ability, but he was inflexibly just and fair, and absolutely incapable of being bribed. When Greece required an upright man she turned without hesitation to Aristides; but just at the moment we are writing about the abilities of Themistokles were far more necessary to the public safety; and as faction spirit between the partisans of the two great men ran dangerously high, an ostrakism was held, and fortunately Aristides had to give way to Themistokles. The policy of Themistokles was to make Athens the most powerful maritime state in Greece. Her geographical position gave her exceptional advantages, and he saw that if she used these advantages wisely, and threw her energies into naval rather than military enterprise, she would not only be the most powerful and richest state in Greece, but would be in a very much better position to meet the Persians, who, he rightly suspected, were secretly preparing for one other and more formidable invasion of Greece. Aristides was opposed to changes which he feared would alter the character of the Athenian people and government for the worse. He thought a seafaring people would not make as good citizens as the peasant farmers, and he predicted trouble from within and from without if the good old ways which had made Athens what she was were now departed from. But the people were won over by the persuasion of Themistokles, Aristides was sent into exile, and a great navy was built with the produce of the new silver mines near Athens. **Aristides.** **Athenian navy.**

Meantime Darius had died (B.C. 485), in the

midst of great preparations for a new invasion. His son and successor Xerxes, a weak, vain man, and a despot of the deepest dye, was persuaded to carry out his father's intentions regarding Greece, though caring little about the matter. But having decided to do so, his vanity led him to enlarge his father's preparations, so that he might lead the greatest force the world had ever seen. For four years more he collected troops and stores from every corner of his vast empire. Forty-six nations were assembled under his banner, and the expedition set out, crossing into Europe by two bridges of boats across the Hellespont (B.C. 480). Herodotus, who wrote not long after that time, assures us with perfect good faith that the troops under Xerxes numbered nearly two

Xerxes prepares to invade Greece.



RUINS AT ÆGINA.

millions, while the naval armament consisted of 1200 triremes and 3000 smaller ships, with over half a million of men, and the non-combatant followers were more numerous than the combatants. His calculations would thus bring the total up to about five millions! We cannot credit this. But there is good reason to believe that they numbered at least a million, and were the largest number of men that ever assembled together for war in any time.

Meantime the Greeks had made but little preparation to meet this immense force. Not until about six months before the Persians crossed the Hellespont had they attempted seriously to unite against the common danger. Then Sparta and Athens did indeed lay aside their mutual jealousy, and summoned a congress of all the other states to meet at Corinth to take measures for their common safety. But even then the states could not all be induced to follow the magnanimous prudence of Sparta and Athens, and some of them probably wished to see these states humbled, even at the cost of the liberty of all Greece. The congress sent 10,000 men to the pass of Tempē; but on arriving there they found such a small number could not defend the pass, so they retired, and a fresh army consisting of about 7000 men, chiefly Peloponnesians, were sent to Thermopylæ—a very narrow pass in the south of Thessaly, through which the Persians would have to force their way to get into Attica. Here, it was thought, that even so small an army as the Greeks could muster might keep the Persian hosts at bay. Leonidas, one of the kings of Sparta, was in command of this army, and with him were 300 Spartans, with Helots and other troops. When the Persians saw this tiny army prepared to dispute their passage, they halted four days to give the Greeks time to see how irresistible their own force was. But the Greeks, to the amazement of the Persians, were not awed into submission, nor so frightened as to run away. Xerxes sent an officer to desire them to give up their arms. "Come and take them," was the reply. "The very arrows of the Persian hosts will conceal the sun." "So much the better," replied Leonidas: "we shall then fight in the shade." At last the Persians advanced to the attack. For two days they made no impression on the Greeks. But in the night following a traitor among the Greeks told Xerxes of an unfrequented way over the mountains by which a force could march over so as to attack the Greeks in the rear. A band of Persians accor-

Thermopylæ.

dingly set out, and the guard which had been set to watch this path having run away in a panic, the Greeks found themselves threatened in rear as well as front, so that it was no longer possible to hold Thermopylæ. A hurried council of war was held. Most of the generals were for retiring at once, while there was time to escape. But Leonidas declared that the others might and ought to retire ; as for him and his Spartans, however, the laws of their country forbade them to leave a post entrusted to them, and they would stay and die at that post. The little army of Thespiæ, consisting of 700 men, declared that they too would die at their post. The rest retired; Leonidas and his thousand heroes threw themselves on the Persians in front before the others in rear had come up. Leonidas fell early in the fight, but his men fought on, each resolved to fight until he fell. At last the Persians behind closed in upon them, and they were surrounded and cut down to a man, refusing quarter. On the spot where they made their last stand a marble lion was erected in honour of Leonidas, and another monument bore the inscription which one of our poets has translated as follows :—

"Go tell the Spartans, thou that passest by,
That here obedient to their laws we lie."

Their example was of great value to the cause for which they died. It inspired the Greeks with fresh courage and enthusiasm, while it must have caused misgivings in the hearts of many a Persian captain.

While the fight was raging at Thermopylæ the fleets had also been engaged, and the Persians had certainly got the worst of it, and had also lost many vessels in the storms, which appear to have been very friendly to Greece. But on hearing that Thermopylæ was forced, the Greek fleet sailed away south, and took up a position in the bay of Salamis, which is not far from Athens. Xerxes marched on Athens ; the Athenians could not oppose him, being deserted by the Spartans, who had retired to guard their own dominions ; so Athens was deserted. Her people escaped in their ships to the neighbouring islands, and Xerxes marched in, opposed only by a few obstinate men who would not leave, and who were easily despatched. The town was burned, the holy places desecrated, and not an Athenian was left alive in the city.

Athens deserted.

But in their ships, thanks to Themistokles, there was still a possibility of resistance. This great commander saw that all was not lost, and by bringing all his energy and influence to bear he succeeded in forcing on a battle then and there. The Greek fleet, numbering about 350, had posted themselves in the narrow passage between the island of Salamis and the mainland. In the night Themistokles was called away from the council of commanders to speak to a stranger. The stranger turned out to be Aristides, who as we saw, had been banished six years before, and had now returned in the hour of his country's dire distress to give what aid he could. He told them that in the darkness of the early night the Persian fleet had surrounded them, and that they must prepare for fight. There is good reason to believe that Themistokles, fearing that his countrymen if they left Salamis would scatter and never be able to face the Persian fleet, had sent a scout with a message to Xerxes that the Greeks would escape him if he did not attack at once, and that on receiving this intelligence Xerxes sent his fleet into the bay of Salamis after the Greeks.

It was now impossible to escape without fighting ; and after a desperate battle, in which the very number of the Persian ships, crowded together as they were in a narrow passage, soon made them an easy prey to the active and now desperate Greeks, two hundred Persian ships were destroyed, and the rest, in a panic, fled. Xerxes, with his vast army, had the mortification of seeing from the shore the shame of his fleet, and in his disgust he decided to throw up the expedition and make his way home. His fleet, still 800 strong, was despatched to the Hellespont, lest the Greeks should attack and destroy the bridge there ; and leaving 300,000 men under his general Mardonius to complete the conquest, he marched back by the same way that he had come, leaving many a tall "barbarian" carcase to mark his homeward path.

Battle of Salamis.

Next spring Mardonius again led the Persians to Athens, and destroyed what the Athenians had rebuilt in the winter. The Spartans selfishly allowed this ; but at last, seeing some chance of ridding Greece of the remaining Persians, they put forth all their strength, and got together the only really large force that ever met the Persians—a force of 110,000 men, under Pausanias. They met near Platæa. After some manœuvring a great battle took place, which resulted in the most complete destruction of the Persians and the capture of their baggage and treasure.

Battles of Platæa and Mykalé.

The very same day the Greek fleet won a great battle over the Persian fleet at Mykalē in Asia Minor, which put an end to Persian rule over the Greek colonies there. And, strange as it sounds, this battle between the fleets was fought on dry land ! The Persians were afraid to face the Greeks on the water, and so landed and drew up their ships on the seashore. The Greeks followed them, routed them completely, and burned all their ships. For this victory the Athenians deserve the chief credit. Thus, on one and the same day, the pretensions of Persia to conquer and rule over Greeks were shattered to atoms, equally in Europe and in Asia, and that mighty empire received a blow from which it never fully recovered. Very soon after this, Byzantium, now Constantinople—one of the few Greek colonies still in Persian hands—was recovered, and the Persians no longer dared to show themselves in the Mediterranean.

The Greeks, on the other hand, emerged from the contest with a surprising development of vigour and enterprise, which showed itself in many forms during the next half-century. Commerce (and its result, wealth,) naval and military prowess, literature and art

Effects struggle with Persia.

flourished in a quite wonderful manner during this period. And as it was Athens who, by her energy and resolution, contributed most to win the struggle for freedom, so it was Athens who took the lead in the new development of literature and art, and thereby won the everlasting gratitude of the human race.

XLI.

The Syntax of the Ablative Case.

The Ablative Absolute.

When a substantive or pronoun, together with a participle or an adjective, form a clause by themselves—*i.e. absolutely* without dependence on or under the government of any other word—they are said to be in the *ablative* case *absolute*, as *hanc rem* SALVIS LEGIBUS *agent*, they do this thing without breaking the laws, or while the laws are still safe. Here observe that *salvis legibus* is the ablative absolute, because it is not governed by and dependent upon any other word or words in the sentence; it simply governs itself, and so is said to be *absolute*.

Observe that participles in the ablative absolute may be construed in the following various ways:—

Regnante Tarquinio { when Tarquin was king. / in the reign of Tarquin. / as Tarquin was reigning. / when Tarquin is king. / as Tarquin is reigning. / although Tarquin reigns. / since Tarquin reigns.

The best rule for construing the ablative absolute is this: Take the ablative case of the substantive as if it were a *nominative*—by which I mean, take it without putting any sign before it—and then take the participle either directly or *as soon after* as you can.

It must be noted, however, that it is not always a *substantive* with a participle that is used, but sometimes it may be an *adjective* (with a substantive of course understood), and sometimes it may be the *relative pronoun*.

Example 1.—"In eodem quondam prato pascebantur anseres et grues. *Adveniente domino* prati, grues," etc., etc.

The Latin words in italics form an ablative absolute. Follow the rule given. Take the ablative case of the substantive (*domino*), but put no sign to it—saying *domino*, the master, *prati*, of the field; and then the participle (which you will find in the ablative case) *adveniente*, coming up: "The master of the field coming up, the cranes easily flew away."

Example 2.—"Mures aliquando habuerunt consilium quomodo a fele caverent. *Multis aliis propositis*, omnibus placuit," etc. *Multis aliis propositis* is an ablative absolute in the plural number. There is no substantive to take, but there are two adjectives, which of course agree with some substantive understood (*consiliis*). So we take *multis aliis*, putting no sign before it, and say *Multis aliis*, many other plans, *propositis*, having been proposed, *placuit*, it pleased, etc., etc., etc.

Example 3.—"Agricola senex quum mortem sibi propinquare sentiret, filios convocavit, quos, ut fieri solet, interdum dissentire noverat, et fascem virgultorum afferri jussit. *Quibus allatis*, filios hortabatur," etc., etc.

Quibus allatis is an ablative absolute, the relative pronoun being used. We take *quibus* (agreeing with *virgultis*, understood), putting no sign before it, and say, *quibus*, which, *allatis*, having been brought to him, *hortabatur*, he exhorted, *filios*, his sons. Notice, too, that *quo facto*, which being done, is also a very common form of the ablative absolute, especially at the beginning of sentences.

When a subordinate clause has a different subject from the subject of the principal clause, the English verb in the subordinate clause is sometimes in Latin expressed by a substantive and participle in the ablative case. This construction is called the ABLATIVE ABSOLUTE—as *sole orto, Romani hostes viderunt*, when the sun had risen [lit. the sun having risen] the Romans saw the enemy.

There is no perfect participle active in Latin, except in the case of deponent verbs. But the English perfect participle active may often be expressed by means of the Latin perfect participle passive, in the ablative absolute—as *Cæsar, exposito exercitu, ad hostes contendit*, Cæsar, having landed the army [lit. the army having been landed], hastens against the enemies.

Observe that it is not the subject of the principal sentence, but it is the accusative after the verb, which becomes the ablative absolute.

The participle is sometimes omitted with the ablative or the absolute ablative—as in *Me duce tutus eris*, I being your guide, you will be safe. Here, however, the noun *duce* seems to do duty for the participle *ducenti*.

The ablative absolute seems really to be an ablative of *time or condition*—hence it is generally rendered *when, while, as*.

Observe that the ablative absolute can never be used except when a new subject is introduced—as, While Cæsar reigns he is safe, *Cæsar regnans salvus est;* but, While Cæsar reigns I am safe, *Cæsare regnante, ego tutus sum*.

Sometimes a perfect participle passive is put into the ablative absolute when the substantive is represented by a whole clause or sentence—as *audito, regem ad Romam venturum esse*, it having been heard (or when it was heard) that the king was about to come to Rome. Here *audito* is the ablative of the pass. perf. participle of *audio*, and has for its subject the whole clause following.

Exercises.

Translate into English the following passages from Latin authors:—

Cæsar, militibus omnibus adductis, ad hostes contendit. Nondum comperto, in quam regionem

venisset. Natus est Augustus, Marco Tullio Ciceronc et Antonio consulibus, excepto, quòd non simul esses, cetera lætus. Si te invito transiri conarentur. Quibus rebus cognitis Cæsar ad suas naves cito revertiretur. Regibus exactis consules creati sunt. Jamque cinis vivis fratribus Hector erat. Quid dicam de hac juventute? Cæsar devictis Gallis Romam rediit. Stricto ense impetum in hostes facit. Mutata militum sententia Brutus hæc facere constituit. Occidit, occidit spes omnis et fortuna nostri nominis Hasdrubale interempto. Cæsar duobus magnis bellis una æstate confectis exercitum in hiberna deduxit. Omnibus rebus confectis domum redibimus. Tota classis mersa est te aspectante. Tarquiniis Roma expulsis, cives pace fruebantur. Milites strictis ensibus ducem petierunt. Vir bonus ille mortuus est circumstantibus omnibus amicis. Omni spe salutis amissa in arcem se recepit. Quibus factis, rus milites rediere ad unum. Christus, imperante Tiberio, crucifixus erat.

Re-translate into Latin the following passages translated from Latin authors :—

A signal being given, the Gauls attack the town which our soldiers were defending with all their might (*summâ vi*). When peace was made (*ablative absolute*) the lieutenants came back to the commander. Their darts having been all thrown, they fought with their swords. The camp being pitched, they prepare to make an attack. The fields having been laid waste, he leads his army home. In the reign of Augustus flourished the greatest of the Roman writers, both poets and historians and philosophers. A very great part of the Roman army having been slaughtered, the Gauls hoped they would conquer. Thou being our leader, O Cæsar, no one can conquer us. So two legions having been routed, the army tried to escape. Hasdrubal having been conquered, Carthage soon perished. The enemy returned after taking the city. Who returned to Rome after conquering the Gauls? Cicero defended Milo in the hearing of many (*say*, many hearing). After crossing the Alps, Hannibal will come into Italy. After reading my letter Cicero spoke as follows. Having discovered gold, they remained there. The Romans defeated the Germans under the leadership of Ariovistus (*say*, Ariovistus being leader). Having finished this book, the boy will enjoy rest. Regulus was slain, his enemies looking on. Were consuls elected when the kings had been driven out? Do not do this again, your crime having been found out. I was made quæstor in the consulship of Sulla (*say*, Sulla being consul). Let us fly, all hope of safety having been lost.

Self-Examination Questions.

What is meant by the ablative absolute? In what various ways can a Latin ablative absolute be translated? Give examples of this by various translations of *Cæsare ducente nos*. Can a participle alone, or can a noun alone, form an ablative absolute? If so, give instances. Why is this ablative sometimes explained as an ablative of time or condition or manner?

XIII.

Rotation—Moments.

§ 57. The lid of a box, a gate, a door, a pendulum, the beam of a steam-engine, are familiar examples of bodies movable about a fixed axis; and the consideration of these will give much useful information as to the efficiency of a given force in producing rotation. This efficiency is technically known as the *moment* of the force. This moment depends not merely upon the magnitude of the force, but also upon its position relative to the fixed axis, as will be seen from an example or two. A lad sitting upon an open gate does not by so doing make the gate open or close unless the hinges of the gate are out of the vertical. The weight of a door has no tendency to open or close the door if the hinges be upright. In these cases we have forces in the same direction as the fixed axes. Such forces tend to make the body slide along the axis, or perchance displace the axis, but there is no tendency to make the body turn round the axis. We may then leave these forces out of sight for our present purpose. This is of some practical advantage, for it enables us to simplify our figures. In dealing with the case of a door we should use a plan, for in a plan the axis appears as a point. The forces as represented on this plan are the only ones that affect rotation. So, in other cases, we always draw a figure in such a way that the axis appears as a point, being seen "end on." In this figure the lines that represent forces parallel to the axis are also seen end on; practically they disappear from the diagram. Moreover, each of the forces which are not parallel to the axis is by this process resolved into two components; one parallel to the axis, which has no moment, and disappears from the diagram, the other in the plane of the diagram, and the moment of this it remains to determine. **Moments.**

First it is clear that the moment of a force depends, in some way, upon its distance from the axis. When the direction of a force passes through the axis, it has no moment about that axis: for example, we know that it is useless to attempt to open or close a door by tugging at the hinges. The following illustration will serve to indicate the mode of measuring the moments of forces. In fig. 31, A B represents a rigid bar, which is free to turn round an axis shown end on at F. For simplicity we shall suppose that the weight of the bar has no effect upon its rotation—a supposition which may be practically realized either by setting the axis upright like the hinges of a door, or by taking the axis so that the bar balances when left to itself. The latter alternative leaves us free to use weights as forces in experiments, and so is by far the more convenient. Suppose a body of convenient weight, suspended at a point P

on the left-hand of the axis, or *fulcrum* as it is usually called. This weight has a certain moment about the axis; and it is clear that if the weight were doubled, the moment would also be doubled. Leaving the body suspended at P, let another of equal weight be suspended at Q on the other side of the fulcrum, and equally distant from it. This new force will have the same moment as the weight at P, and since the moments are one clockwise, the other counter-clockwise, they will just balance. It is worth while to notice that if we make the bar move a little, the one body will sink just as much as the other rises—the work done on one side is just equal to that undone on the other. This equality of work is a test of equilibrium which will be useful in the sequel.

So far we have been dealing with forces at equal distances from the axis; we must now consider the case in which the forces are not equally distant from the axis. Let us leave the first mass hanging at P, and suspend another from R on the opposite side of F, and twice as far away. If the mass at R had the same weight as that at P, there would not be equilibrium. For when P sinks, say one inch, R rises just double the distance, or two inches. If we wish to have the work done on one side equal to that undone on the other, we can effect this by doubling the weight that tends to pull P down. Now, when the weight at P is doubled the moment is doubled; so that the moment of the R force is just double of the moment of an equal weight acting on P. In fine, the moment of a force may be doubled either by doubling the force in the same place or by letting the force act at double the distance from the axis. In all this there is no special virtue in the number 2: we might have employed any number or fraction instead; but by using 2 we avoided the risk of complicating the matter with roundabout phrases such as "five and a half times as great" instead of "double." The conclusion holds good whatever the special number we use, as the reader may find by trial.

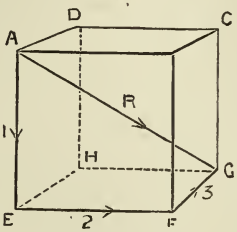


FIG. 30 (*see* p. 420).

These results enable us at once to get a measure of the moment of a force acting at a given distance from an axis. Say we have a force of 6 poundals acting at a distance of 3 feet from a certain axis. We know that this has 3 times the moment of the same force acting at a distance of 1 foot. A force of 6 poundals at 1 foot has 6 times the moment of 1 poundal at 1 foot. Hence the given force has 18 times the moment of 1 poundal acting 1 foot distant from the axis. In general we may measure the moment of a force about an axis by multiplying the force by the distance of its direction line from the axis. It must be remembered that all forces parallel to the axis are to be excluded in making this calculation—though this preparation is generally unnecessary owing to the absence of such forces. Also by "distance" must be understood "shortest distance," since otherwise the word is meaningless, or at any rate has no definite meaning.

Measure of a moment.

§ 58. The results of the last article enable us to represent moments in a manner similar to that adopted (§ 55) for rotations. The direction of the representative is the axis about which moments are taken; and of the two opposite directions thus offered, we select that in which an observer must look to see the moment acting clockwise. The length of the line is given by the magnitude of the moment, as determined by the method of the last article. The resultant or combined effect of moments about several axes through one point may be determined in the manner now familiar to our readers—viz., by "adding together" the lines representing the several moments, each line being drawn in its proper direction and length, beginning at the end of its predecessor. The line joining the first to the last point of the diagram will represent the resultant moment.

Equilibrium Examples.

§ 59. It is now time to show how the results hitherto obtained may be applied. In almost all applications we shall have to answer questions about forces in equilibrium, and it will be well to make sure of the meaning of this phrase. A set of forces acting on any body are said to be in equilibrium when their combined effect on the motion of the body is nil. Thus, the forces that act upon a train at rest are in equilibrium. So, too, the forces that act upon it when it is going straight ahead at full speed are in equilibrium, for the motion is not changed by these forces. When the train slackens speed, or when it is going faster and faster, or when it is moving along a curve, the forces are not in equilibrium, for in each of these cases the motion is undergoing change. It is also true that when the forces are in equilibrium the motion of the body continues unaltered.

Equilibrium.

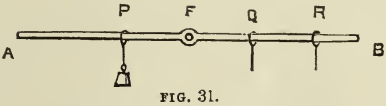


FIG. 31.

There are some special cases of equilibrium which may be noticed separately, since the results of these simple cases are of much use in practical applications. It is almost superfluous to remind readers that anything proved about forces may be at once applied to moments by means of the straight-line representation described in § 58.

§ 60. The case in which two forces are concerned may be very briefly dismissed. They must be equal in magnitude, opposite in direction or sense, and their directions must be in the same straight line. It is a very easy matter to prove this, and the proof may be left to the reader, with this hint:—find the resultant of the forces, and take moments about any point in the line of one force.

Two forces.

The result is of some importance, as it enables us to deal with the weight of a body

in a convenient manner. If a chair, for example, be suspended by means of a cord, as in fig. 32, it will assume a definite position. One of the forces acting upon it is the tension of the string, the direction of which is known. The weight of the chair also acts upon it, and is just balanced by the tension of the cord. It appears, therefore, that the weight of the chair acts along a line, the dotted line in fig. 32, which can easily be found by experiment, or, as will be seen in the sequel, by calculation.

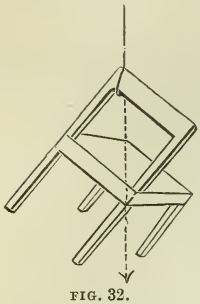


FIG. 32.

§ 61. The case in which three forces act upon a body is somewhat more complicated, but at the same time the results are more often useful.

First, suppose that two of the forces meet at a point. Then we can show that the third force must also pass through the point. For the two forces first mentioned have no moment about any axis through the point of meeting. The third force has, unless it passes through the point. In other words, if the third force does not pass through the point in which the others meet, there is an unbalanced moment, and the body will begin to turn round. So, if we know that the body is in equilibrium, and if we also know that the direction of two forces meet in a point, we can infer that the third force also passes through that point. Some examples which will presently be given will show how useful this is.

Three forces.

§ 62. In very much the same way we can prove another important property of three forces in equilibrium : namely, that they lie in the same plane, so that it is possible to draw their lines of action on paper without perspective. If there were three forces acting along the lines A D, C G, and E F in fig. 30, these could not balance because they are not in one plane, and cannot be drawn except in perspective. To prove this, take any axis meeting two of the force-lines. For instance, A G is such an axis. The two forces have no moment round this axis, but the third has, unless it meets the axis.* Thus it appears that every straight line that passes through two of the force-lines, passes through the third,* and this is only another way of saying that the three force-lines are in the same plane.

This result enables us to give the second case in which three forces may be equilibrium. In fact, if no pair of lines meet, though in the same plane, they must all be parallel. We have thus learned that if three forces be in equilibrium they must be in one plane, and either meet in a point or they must be parallel.

* Or is parallel to it. These words should have been added to the text, in the places indicated. They have been omitted to simplify the statement; but students of geometry will see that the result is unaffected.

XXXIV.

THE VERB (*continued*).—THEORY.

I. Some further remarks on the agreement of the verb with its subject.

a. A series of subjects is sometimes summed up by some general term—such as *aucun, chacun, nul, personne, rien, tout*—which either precedes or follows the series; in that case the verb agrees with the general term :—

Hommes, dieux, animaux, tout y fait quelque rôle, *men, gods, animals, everything plays some part in it.*—Remords, crainte, périls, rien ne m'a retenue (Racine), *remorse, fear, perils, nothing has held me back.*—Tout le monde, noble, bourgeois, artisan, laboureur, y devient soldat (Montesquieu), *every one—noblemen, burgesses, mechanics, husbandmen—there becomes a soldier.*

b. The verb usually agrees with the former of two subjects when they are presented together with the conjunctive phrases *ainsi que, aussi bien que, comme, de même que, non plus que*, etc.

La vertu, de même que le savoir, a son prix, *virtue, like knowledge, has its worth* = la vertu a son prix, de même que le savoir a son prix.—Son esprit, non plus que son corps, ne se pare jamais de vains ornements, *his mind, no more than his body, ever bedecks itself with vain apparel* = son esprit ne se pare jamais de vains ornements, non plus que son corps ne s'en pare.—Le soleil, comme la gloire, réchauffe même la tombe (Mme de Staël), *the sun, like glory, warms even the tomb.*

c. In English, collective nouns conveying plurality of idea require a verb in the plural. Use the singular in the corresponding French :

Le peuple *réclame ses* droits, *the people* claim their *rights.*—L'équipage se *reposait* de *ses* fatigues, *the crew* were resting *from* their *fatigues.*—La foule *poursuit* ardemment le plaisir comme *son* plus grand bien, *the multitude eagerly* pursue *pleasure as* their *chief good.*

d. A case which presents some difficulty is that of a collective followed by its complement —that is, by the word which shows of what the collection consists. If the collective be general—that is, embracing the totality of the objects named—as *the crowd of stars*, which means *all* the stars, the collective becomes the leading idea, and the verb agrees with it. In that case the collective is usually preceded by *le* or *la*.

L'infinité des perfections de Dieu m'*accable, the infinity of God's perfections* overwhelms *me.*—La *foule* des humains *est* sujette à l'erreur, *the totality of human creatures* is *prone to erring.*—Des enfants qui naissent, la *moitié* tout au plus *parvient* à l'adolescence (J. J. Rousseau), *of the children born the half at most* reaches *adolescence.*

If the collective be partitive—that is, embracing only a portion of the objects named, as *a crowd of stars*, which means a *portion* of all the stars—the complement becomes usually the principal thought, and in that case the collective is preceded by *un* or *une*. Much, in some cases, depends on the point of view which the writer chooses to take; and feeling our incapacity of indicating a general principle, we shall examine by turn the collective expressions which present themselves most frequently in speech.

FORCE.—Used absolutely means *a great quantity of*, and is always subordinated to its complement, with

which the verb agrees: *Force* gens croient *être plaisants* qui *ne* sont *que ridicules* (Balzac), a great number of people think they are amusing while they are only ridiculous.

FOULE.—Preceded by *une*, offers the greatest latitude: one may say Une foule *de gens* s'est opposée *à mon départ*, or *Une foule de* gens *se* sont opposés, a crowd of people *has* or *have* objected to my departure.—*Les uns coururent se jeter dans la rivière de Narva, et une* foule *de soldats* y fut noyée (Voltaire), some ran and threw themselves into the Narva river, and a *crowd* of soldiers *was* drowned in it.—*Une foule de* personnes *y* coururent, a crowd of people ran to it.—*Une foule de monde y consent* offers, of course, no difficulty.

INFINITÉ.—Preceded by *une* causes the verb to agree with the complement, in conformity with the (tentative) general rule: *J'ai eu cette consolation en mes ennuis qu'une infinité de* personnes ont pris *la peine de me témoigner le déplaisir qu'elles en ont eu* (Malherbe, as quoted by Littré), I have had this comfort in my troubles, that an infinity of persons have gone out of their way to express to me the sorrow which they have felt on account of them.—*Il y en a une infinité* qui pensent, there is a vast number of them (people) who think. [Here *en*, of them, completes *infinité*, and *pensent* agrees with *qui*, of which *eux*—because *en* = *d'eux*—is the antecedent.]—*Une infinité de* monde *se* jette *là-dessus* offers no difficulty.

MULTITUDE.—Preceded by *une*, allows option: *une multitude de sauterelles* ont (or *a*) *infesté ces campagnes*, a host of locusts *have* (or *has*) *infested these fields.* [In this phrase *La multitude des hommes qui environnent les princes est cause qu'ils n'en remarquent aucun*, we find *multitude*, collective general, subject to *est*, but also *hommes* antecedent to *qui*, with which *environnent* agrees.]

NOMBRE.—Used without an article means a great number, and is followed by the verb in the plural: *Nombre de couvents* furent supprimés, a great number of convents *were suppressed.*—*Nombre de dissertateurs qui raisonnent à l'infini* (Vauvenargues), here the verb agrees with *qui*, but the antecedent is *dissertateurs*, in conformity with the spirit of the rule. When *nombre* is accompanied by the article, the verb appears in the singular, agreeing with *nombre:* Un nombre *de quatre cents soldats* fut formé *des débris du régiment*, a *total* of 400 men *was formed* with the wrecks of the regiment.—Un nombre *de corbeaux, aussi* funeste *qu'elles* a *quelque temps après* redoublé *mon effroi* (Rotrou), a number of ravens, as ominous as they, *has* sometime afterwards *increased* my terror.

After *un grand nombre*, followed by a complement, the verb may be put in the singular or plural:

Un grand nombre de soldats fut tué dans ce combat (Littré).	Un grand nombre de personnes avaient été conviées à la cérémonie (Acad.)
Un grand nombre d'hommes peut être nuisible à l'état (Marmontel).	Un nombre infini d'oiseaux faisaient résonner ces bocages de leurs doux chants (Fénelon).

After *un petit nombre* the verb appears preferably in the singular: *D'adorateurs zélés à peine* un petit nombre ose *des premiers temps nous retracer quelque ombre* (Racine), hardly a small number of worshippers *dares* to recall to us some faint shadow of early times.—*Le* petit nombre *de ceux qui courent après lui ne* peut *l'atteindre* (La Bruyère), the small number of those who pursue him *is not able* to overtake him.

NUÉE.—Is generally considered as presenting the more important thought: Une nuée *de traits* obscurcit *l'air et* couvrit *tous les combattants* (Fénelon), a cloud of darts darkened the atmosphere and covered all the combatants.—*Des* nuées *d'Arabes* furent appelées *en Égypte pour remplacer les habitants que la misère avait détruits.*—*Une* nuée *d'écrivains* s'abat *journellement sur Paris* (Larousse).

LA PLUPART.—Taken absolutely, requires the verb in the plural: La plupart emportés *d'une fougue insensée toujours loin du droit sens* vont *chercher* leur *pensée* (Boileau), most (of them) carried away by a mad impetuosity always look for inspiration far from good sense.

Observe how *emportés* and *leur* are influenced by that plural complement understood after *la plupart*.

When *la plupart* is followed by a complement it is with the latter that the verb agrees. Compare *la plupart du sénat fut d'avis* with *la plupart des sénateurs furent d'avis.*

PLUS D'UN.—Governs the following verb in the singular, unless there be an idea of reciprocity connected with the verb: *Plus d'un guéret* s'engraissa *du sang de plus d'une bande* (La Fontaine), more than one furrow fattened on the blood of more bands than one.—*Plus d'une Pénélope honora son pays* (Boileau), more than one good wife has done credit to her country.—But *à Paris on voit plus d'un fripon qui se* dupent *l'un l'autre*, in Paris you see more rogues than one who cheat each other.

QUANTITÉ.—The verb agrees with the complement: *Quantité de soldats sont arrivés*, a great quantity of soldiers have arrived.—*Quantité d'oliviers ont été gelés cet hiver*, a great quantity of olive-trees were frozen this winter.

TROUPE.—With this word it is optional to make the verb agree with the collective or the complement

Une troupe de fantassins armés à la légère *formait* l'avant-garde.	Une troupe de nymphes *étaient assises* autour d'elle (Fénelon).
Cette troupe de jeunes gens que j'ai *vue* or *vus* (Littré).—This phrase merely shows that *troupe* or *gens* may be viewed as the antecedent.	Une troupe de soldats qui pillèrent le château, sera mieux qu'une troupe de soldats qui pilla le château (Condillac).—Why? Because the idea of *piller* is more readily coupled with soldiers.

e. The verb standing in the impersonal form is always singular, agreeing with the apparent subject *il*, and never, as in English, with the real subject: *Il* croît *de beaux arbres dans ce jardin*, there *grow* fine trees in that garden; *Il en* naîtra *d'heureux souvenirs*, there *will grow* from it happy reminiscences.

(For the agreement of the verb after the demonstrative and the relative pronouns, subsequent chapters will require to be consulted.)

Practical Application.

I. VOCABULARY XVIII. (being a sequel to Voc. XVII.)

Les Animaux et leurs Cris—*Animals and their Cries.*

l'abeille, f., *bee*	bourdonner, *to hum*
l'aigle, m., *eagle*	trompeter, *to trumpet;* glapir, *to shriek*
l'alouette, f., *lark*	grisoller, *to carol* [*to hoot*
la chouette, *owl*	chuinter, huer, *to screech,*
la cigale, *locust*	craqueter, *to chirp* [*clatter*
la cigogne, *stork*	craqueter, claqueter, *to*
le colibri, *humming-bird*	bourdonner, *to hum*
le corbeau, *raven*	croasser, } *to croak*
la corneille, *crow*	crailler, }
le coucou, *cuckoo*	crier, *to cry*
le crocodile, *crocodile*	lamenter, *to whine*
le cricri, *cricket*	chanter, *to chirp*
l'éléphant, m., *elephant*	bareter, *to trumpet*
le geai, *jay*	cageoler (*or* cajoler), *to*
la gelinotte, *wood-hen*	glousser, *to cluck* [*chatter*
la grenouille, *frog*	coasser, *to croak*
la grue, *crane*	glapir, trompeter, *to shriek*
le hanneton, *cockchafer*	bourdonner, *to hum*
le hibou, *owl*	chuinter, huer, *to screech, to hoot*
les insectes, m., *insects*	bourdonner, *to hum*
le merle, *blackbird*	siffler, *to whistle*
le moineau, } *sparrow*	pépier, *to chirp*
or passereau, }	
la mouche, *fly*	bourdonner, *to hum*
les oiseaux, m., *birds*	chanter, *to sing;* siffler, *to*
le perroquet, *parrot*	parler, *to talk* [*whistle*
la pie, *magpie*	jacasser, *to chatter*
le pinson, *chaffinch*	ramager, *to warble*
le ramier, *wood-pigeon*	caracouler, roucouler, *to*
le rossignol, *nightingale*	chanter, *to sing* [*coo*
la sauterelle, *grasshopper*	craqueter, *to chirp*
le serpent, *serpent*	siffler, *to hiss*
la tourterelle, *turtle-dove*	gémir, *to coo*

II. REMARKS ON SOME VERBS OF THE FIRST CONJUGATION.

a. On verbs in *ger*—as *manger*, to eat. In all cases where the termination begins with *a* or *o*, an *e* mute requires to be inserted between it and the stem *mang*, in order to preserve the original sound of *g*, which in *manger* is a soft sibilant, and which before *a* or *o* would become a soft guttural (*see* vol. i., p. 379, § 62). For example, the present participle of the model being *parlant*, the present participle here should be *mangant;* this, however, gives the sound *mangh'*—a mute *e* is thus inserted to restore the original *manzh—mangeant*. By referring to the model given in our next article, it will be seen that this insertion occurs eighteen times in the course of the conjugation.

b. On verbs in *cer*—as *placer*, to place. Whenever the stem of this word is followed by an *a* or *o*, a *cedilla* must be placed under the *c*, in order to preserve the original hard sibilant sound observable in the infinitive, and prevent its becoming a hard guttural (*see* vol. i., p. 352, §§ 56 and 58). The present participle of the model being *parlant*, the present participle here should be *plaeant;* this, however, gives the sound *plak';* a cedilla is then put below the *c* to restore the primitive sound *plass—plaçant*. This change, of course, happens as often as the introduction of *e* mute, as mentioned in *a*.

c. On verbs in *yer* — as *ployer*, to bend. These verbs change *y* into *i* before an *e* mute; this occurs twenty-one times in the verb. With verbs in *ayer* and *eyer* it is usual to retain the *y* throughout. The presence of *y*, as will be seen in the model (*see* Art. XXXV.) does not absorb the *i* of the termination in the first and second persons plural of the imperfect indicative and present subjunctive. In a like manner, it will be observed that verbs in *ier*—as *nier*, to deny —exhibit two *i*'s in the same positions; the former belonging to the stem, and the latter to the termination: nous *niions*, *vous niiez*, *que nous niions*, *que vous niiez*.

FIG. 206.—GRIFFINIA BLUMENARIA.

d. On verbs in *éer*—as *créer*, to create. These have two *e*'s throughout their conjugation, except before *a, i, o: je crée, tu crées, il crée, ils créent;* but *il créa*, he created, *nous créons*, we create, *vous créiez*, you were creating. This amounts to saying that such verbs are strictly regular, and it is given merely as a useful hint for correct spelling. There are only nine verbs of this kind. These nine are the following:—

créer, *to create*	gréer, *to rig*
recréer, *to create again*	agréer, *to accept*
récréer, *to refresh*	désagréer, *to disagree*
procréer, *to beget*	ragréer, *to finish*
suppléer, *to make up for*	

BOTANY.

XLI.

VARIOUS ORDERS (*continued*).

WE have had examples of various oddities in flower and fruit structure. Coming to the Crassulaceæ, we learn how playful nature can be in the matter of Leaves. In this very pretty and rather extensive family of herbaceous plants and undershrubby ones, a thin, flat leaf, such as that of an apple-tree, is probably unknown. In every instance, so far as we know, the leaf is immensely distended with juice, so as to be often like a green bag of water, the veins scarcely distinguishable. The figures and outlines assumed by the leaves are frequently also very odd. Illustrations of the order are extremely common, being found in the numerous kinds of sedum or stonecrop, both indigenous and exotic, valued for the sake of their bright-hued and cheerful flowers, especially upon rockeries. What is there more charming, in its way, than the little golden stonecrop, Sedum acre, which sits, like epaulettes, upon every old wall, in the limestone districts,—or the silvery-white *Anglicum* of the seaside cliffs? Upon rural walls, especially near cottages, we find also that very curious plant, the houseleek, the leaves produced in dense rosettes, that seem more like castings in metal than simple foliage. The same remarkable character recommends for the garden those beautiful plants called echeverias, now so commonly seen disposed in long rows as a kind of edging to the borders. The most curious and some of the most brilliant forms of the crassulaceous plants are natives of the Cape of Good Hope. Hence in our own country they require the constant protection of glass. Others, of great attractiveness, come from Madeira and the Canaries. These foreign species include the true and original crassulas, so named because of the fleshiness of every portion. The flowers of these plants are almost always pentamerous, the only deviation being in the houseleeks, which have all the parts in twelves, and in the very exceptional Septas, in which, as the name implies, they are all in sevens. In any case the flowers are quite regular, and in the sedums exquisitely stellate. The ovaries, five in number, become little follicles, which discharge innumerable minute seeds. No par-

The Crassulaceæ.

ticular properties have been observed in the plants of this family. Occasionally they are acrid or biting, but as a rule, quite neutral. Every colour proper to flowers occurs among them, but the blossoms seldom evolve odour.

Some very ornamental trees, some elegant shrubs, and a great many herbaceous plants, are brought together by the peculiarities which mark this very interesting order. So slightly, however, is it illustrated in England, that it will suffice to notice the Tilias, the "lindens" or "limes" of the park and pleasure-ground, after which the family is named. The common linden, Tilia Europæa, is acknowledged to be one of the most telling of all decorative trees, belonging naturally to the Continent across the Channel. Hence the frequent use of the name by the poets. Fénélon assigned lindens to the home of Calypso. The tree is told readily, alike by the leaves, and in July, by the flowers. The former are roundish-cordate, pointed, serrate, and remarkable in having the portions right and left of the midrib of different dimensions, so that when folded upon the midrib one side very considerably overlaps. The delicious flowers come out in little bunches of three or four, the stalk attached to a very curious and characteristic bract. Individually they are pale-yellowish, pentamerous, cup-shaped, with many stamens, and a superior ovary, which ripens into a downy capsule the size of a pea. Brimming with honey, they offer a banquet to the bees, and the hum made by these industrious little workfolk attracts as much attention as the beautiful aspect of the tree. The common linden, met with in parks and pleasure-grounds, is probably a fine variety or descendant of the wild English Tilia parvifolia, an inhabitant of the woods in the midland and southern counties. It is to be regretted that the name should have been so much corrupted: *i.e.* first into "line"—"Come, hang them on this line," says Shakespeare; then into "lime," since lime is the appellation, as we have seen above, of one of the orange-tree family, to which alone it by rights belongs. The wood of the linden is greatly esteemed by carvers;—it is worthy of note also that aged trees are apt to have the centre filled with a brushwood of twigs and shoots, that form an impervious mass, and offer a safe refuge to little birds, when chased by one of the Raptores, such as the sparrow-hawk. Several very remarkable examples of the asylum thus produced, may be seen in the delightful grounds belonging to Holker Hall, the Lancashire seat of the Duke of Devonshire. Very few plants of this order occur in gardens or greenhouses. We know, indeed, of only one—that lovely Cape suffrutescent species, the Sparmannia, that no conservatory should be without. Many plants

The Tiliaceæ.

FIG. 207.—PEPPER.

of this order are noted for the toughness of their stem-fibre or the tenacity of their bark, when torn off in longitudinal strips. The common "bast," used by gardeners for tying up, comes from the linden itself;—the more delicate "Cuba bast" is supplied by the Paritium elatum. Jute, now so extensively used in manufacturing, is the fibre of an East Indian corchorus. Nothing poisonous occurs in this family, nor anything edible or medicinal—nothing, at least, of the slightest moment.

The remarkable irregularity of the leaf of the common linden-tree has somewhat of a parallel in the leaf of the common elm. It may be well accordingly now to notice the small but very interesting order named from the latter, in Latin, the Ulmus campestris. All the members are trees, generally large ones, and natives of cold and temperate climates in the northern hemisphere. They are excellently represented in the two British species, there being, in addition to the campestris, another beautiful tree called the wych elm, Ulmus montana. The leaf in each is ovate, pointed, sharply and finely serrated, and with a very short petiole. The irregularity consists not exactly, as in the linden, in a great widening out upon one side, but in the two halves coming down to different points upon the petiole, so that it appears as if on the smaller side it had been cut away with scissors. The flowers of these two trees make their appearance very early in the spring, long before the leaves are developed. They consist of little tubular and pentamerous perianths, a good many of which are crowded together into sessile umbels, the result being that at a short distance the twigs seem to be covered with dark knots. The five stamens fertilize a little two-lobed stigma, the ovary when ripe becoming a thin, flat, green, and leafy samara. Several species of exotic elm occur in arboreta. There are species also in cultivation of the genera Planera and Celtis, but the two trees above mentioned are the only ones likely to come under general observation.

The Ulmaceæ.

Here, as among the Polygonaceæ, we find flowers of very simple structure, the perianth being single. Usually also it is very small, so that were it not for the dense crowding together of very numerous individual blossoms, the plants would have little to offer in the way of floral beauty. In many cases the flowers are accompanied by bracts, very numerous, and of some brilliant colour, red or crimson usually, sometimes golden or greenish. When, as generally happens, the bracts are dry and scarious, or chaff-like, they have a high polish or exquisite glossiness, so that the mass of the inflorescence becomes after all extremely handsome and effective. The bracts of these latter

The Amarantaceæ.

are usually imperishable; whence the name of the family—literally the "unfading." It is not taken from the Greek word for a flower, *anthos*, but from the adjective *amarantinos*, the "non-withering," the word employed in the New Testament in the phrase "a crown that fadeth not away." To mark this is important, because many people contend for amaranthus and Amaranthaceæ. In English it may be right enough to use the *th*, as in Milton's "immortal amaranth," but in Latin it is wrong. In this family we find the gorgeous cockscomb, which seems a mass of crimson velvet; the pyramidal celosia, like a great plume of crimson or golden feathers; and that universal favourite for the greenhouse, the globe-amaranth, the round heads of which are of the richest violet-purple, and endure indefinitely. Loveliest of all is the Australian trichinium, an inexpressibly beautiful combination of pure rose-colour and lustrous silver threads, lasting for ever, most easy to cultivate, but ordinarily neglected for the sake of die-away painted leaves, or a plethora of calceolarias. The glory of a greenhouse, as of a library, is not to have fifty specimens of the same thing, but fifty quite different of the choicest. Many of the Amarantaceæ are unattractive, weedy, and insignificant. The family, as a whole, is of little account, but redeemed by the above-mentioned plants. All the species are herbaceous; none are deleterious.

The Chenopodiaceæ.

The Chenopodiaceæ, another rather large group of herbaceous plants, possess even fewer claims upon our regard as objects of beauty, the flowers being invariably insignificant, and though usually aggregated, after the manner of those of the Amarantaceæ (with which they correspond also in general structure), never showy. But many of them are very useful, supplying esculents available for human use. Such are the common spinach of the kitchen-garden, and certain species of the typical genus chenopodium. Waste land, and the seashore, just above high-water mark, generally present abundance of some kind of orache. On the seashore again, where wet and muddy, we find that very singular plant, the Salicornia. The common salt-wort, with other species that luxuriate upon the seashore, supplies, when burned, abundance of the impure carbonate of soda commercially known as barilla, consumed in immense quantities by the glass-makers. The microscope brings out many very pretty characteristics of the common field chenopods; and in a few instances, a plant adapted for the decoration of the flower-garden may be distinguished. The order, after all, must be classed with the homely ones.

The Piperaceæ.

The peppers, very nearly allied to the preceding, have quite as little to offer in the way of floral attraction. Yet an order which supplies us with a condiment so precious as the pepper of the dinner-table, justly claims a place in the list of worthy ones. All the species are tropical or sub-tropical, herbaceous, weedy, and with the minutest of flowers—which last, were they not generally collected into dense spikes or long racemes, would be liable to be overlooked altogether. The pepper bought in the shops is the produce of an East Indian plant with rather large ovate and alternate leaves, and racemes of little white flowers, which in due time are succeeded by red berries, the cluster of ripe fruit bearing no distant resemblance to a bunch of red currants. These berries, when dried, are the ordinary black peppercorns of the kitchen, the juicy red skin becoming hard and corrugated. When the skin is removed, they become "white pepper." Several other members of this family yield articles of value in cookery or in medicine; and a good many are cultivated in hothouses as curiosities, the inflorescence being like the tail of some little mammal, such as a mouse or a rat. These are chiefly Peperomias. Singular to say, one of the species of Peperomia, the resedæflora, bears flowers resembling mignonette. No representative of this family occurs wild in Europe.

XL.

Parsing and Analysis of Sentences.

§ 241. Value of Parsing and Analysis.
§ 242. Parsing: examples.
§ 243. Explanation of terms: phrase; different kinds of sentence.
§ 244. The Simple Sentence: (*a*) subject, (*b*) enlargement, (*c*) predicate and extensions, (*d*) object.
§ 245. Examples of Simple Sentence.

§ 241. In the foregoing chapters we have, examining the language which is ours at this day, studied the Classification of *Words*, the Inflexions or changes which they undergo in various use, and the principal rules which govern their arrangement. The classification of the *Sounds* which we utter, how we write them down, and how these affect grammatical forms of words, were dwelt upon in the chapter on Orthography (§§ 102—127). To increase his knowledge in this latter branch the student may practise frequently with his own voice, and by observation of the utterance of others, trying vowel and consonantal sounds according to the tables and facts given: these exercises must be done aloud. To test his knowledge of Etymology and Syntax two methods are employed—*Parsing* (from the Lat. *pars*, a part), which deals with words individually, as "parts of speech"; and *Analysis of Sentences*, which deals with words in groups. The first is commonly called Grammatical analysis, the second Logical analysis. In parsing we take a paragraph to pieces and examine every word, stating all the facts about it according to classification, inflexion, and syntax; the kind of word, why it is in such a form and position, what power it has, and what its relations are to other words: all this is an exercise in finding out the facts which the

science of grammar teaches. But as grammar is itself a logical science, it is right to explain that Logical Analysis does not exclude grammatical facts, but, on the contrary, extends the application of the principal notions found in those facts from single words to groups of words. Parsing of words must precede parsing of sentences. The value of practice in this last kind of analysis, as a means of gaining mastery over language and expression of thought, is strongly insisted on, and cannot be better told than in the words of Dr. Angus: "We combine with these processes [of parsing] the analysis of the sentence as a whole, in its *logical* connexion; that is, as an expression of thought. Whatever plan be adopted in carrying out the details of this method, such an analysis is of the utmost importance. Without it grammar is either merely the science that names our tools, or a classification of forms according to the rules of accidence or of syntax, or at most an exercise in comparative philology. [The doctor did not feel the high interest and value of the historic treatment.] With it, grammar becomes an intellectual exercise of the most instructive kind, strengthening the reasoning powers of the student, and rewarding him for the exercise of them by adding to his stores of thought." We will now indicate some methods, and give a few examples of each.

Parsing.

§ 242. This may be done *vivâ voce* or in writing—the latter ensures exactness. The simplest method is to arrange the words of the sentence one after another on the left-hand of a sheet of paper (or slate), writing what has to be said of each on the continuing line. The student may (1) at first merely classify his words according to their character, described in Chapter IV. (§§ 65—101); afterwards (2) he should give the full grammatical account of each word, as taught by the chapters on Inflexion and Accidence (§§ 128—228), and of its position among other words as shown by the rules of Syntax (§§ 229—240). Take the following sentences:—

(1) "A few days after the eruption of Vesuvius, in February, I ascended the mountain, in company with a friend, and attended by Salvatore, the well-known chief guide." (WALKER'S *Original.*)

A	Adjective, indefinite.
few	Adjective, indefinite, used as noun (*of* understood).
days	Noun, common.
after	Adverb of time.
the	Adjective, demonstrative.
eruption	Noun, common.
of	Preposition.
Vesuvius	Noun, proper.
in	Preposition.
February	Noun, proper.
I	Pronoun, personal.
ascended	Verb, transitive, weak conjugation, active voice.
the	Adjective, demonstrative.
mountain	Noun, common.
in	Preposition.
company	Noun, abstract.
with	Preposition.
a	Adjective, indefinite.
friend	Noun, common.
and	Conjunction.
attended	Participle used as adjective.
by	Preposition.
Salvatore	Noun, proper.
the	Adjective, demonstrative.
well-known	Adjective, compound.
chief	Adjective of quality.
guide	Noun, common.

(2) "A simple child
That lightly draws its breath,
And feels its life in every limb,
What should it know of death?"

A	indefinite Adjective, refers to "child."
simple	Adjective, attribute of "child."
child	common Noun, sing. numb., neut. gend., nominative absolute.
that	relative Pronoun, neut. gend., sing. numb., to agree with antecedent "child"; nom. to verb "draws."
lightly	Adverb of quality, modifies verb "draws."
draws	active trans. Verb, strong conjugation, indic. mood, pres. indef. tense, 3rd pers., sing. numb., to agree with nom. "that."
its	possessive Adjective-Pronoun, 3rd pers., sing. numb., neut. gend., to agree with "child," attribute of "breath."
breath	common Noun, sing. numb., neut. gend., objective case governed by verb "draws."
and	Conjunction, joins the sentence "that draws," etc., to "that feels," etc.
feels	active trans. Verb, strong conjug., indic. mood, pres. tense, 3rd pers., sing. numb., to agree with nom. "that" understood to be repeated.
its	possessive Adjective-Pronoun, 3rd pers., sing. numb., neut. gend., to agree with "child," attribute of "life."
life	common Noun, sing. numb., neut. gend., objective case governed by verb "feels."
in	Preposition, joins "life" to "limb."
every	distributive Adjective, attribute of "limb."
limb	common Noun, 3rd pers., sing. numb., objective case gov. by prep. "in."
what	interrogative Pronoun.
should	past tense of auxiliary Verb *shall*, used as independent verb, = is able.
it	personal Pronoun, 3rd pers., sing. numb., neut. gend., nom. to "should."

know	intransitive Verb, strong conjug., infinitive mood after verb "should."
of	Preposition, joins "know" and "death."
death	abstract Noun, sing. numb., objective case after prep. "of."

Frequent practice in this kind of parsing, on short passages taken from newspapers, or any book at hand, forces the student to use his reasoning powers in determining the value of words, and prepares the way for the more extended and interesting examination of notions in sentences.

Analysis of Sentences.

It was said above that grammar is a logical science—that is, it is based upon reason, one step leading to another. The student who has carefully followed the earlier chapters will, it is hoped, find that he already possesses some of the chief heads of analysis; for in truth, while taking our sentence to pieces, it is best to study grammatical and logical analysis together, as the one illuminates the other. The infinite variety of thought gives infinite scope for expression by language, yet the construction of the language is built upon but a few leading principles.

§ 243. *Explanation of terms.*—A *Phrase* is a group of two or more words not containing any finite verb (see § 230)—as "by day," "a man of words," "William the Conqueror," "in going to my lonesome bed" (see further, § 249). There are three kinds of *Sentences*—Simple, Compound, and Complex. A *Simple Sentence* contains a finite verb; it consists of Subject and Predicate—as "John falls," or Subject, Predicate, and Object—as "Thomas beats Philip." Each one of these may be added to or *enlarged;* but however many words the sentence contains, if there is only one finite verb it is still a Simple sentence. A *Compound Sentence* is formed of simple sentences joined by conjunctions which permit equality; each such sentence gives complete sense in itself, without depending on the other. Ex.: "The door was locked (and) she was out," "here are two apples, (but) there are four oranges." These separate sentences within the compound sentence are called *co-ordinate clauses.* A *Complex Sentence* consists of a simple sentence containing the chief assertion, to which another is joined, the meaning of which depends on the first. Ex.: "He told them (how) a truce was made." The first is called the *Principal clause*, the second the *Subordinate clause.* Sometimes the subordinate clause is placed before the principal, as, "Lord, if Thou hadst been here, my brother had not died" (John xi. 32). Thus it appears that all composite sentences are formed by the grouping together of simple sentences.

§ 244. **The Simple Sentence.**—The Subject and Predicate, or *agent* and *assertion*, are necessary elements to every simple sentence: the subject is a noun, or word or words which will represent one, the predicate is a verb (see § 81). Thus in "corn grows" we have just a noun and a verb. In "dogs eat meat" we have Subject, Predicate, and Object, for in this case the sense of the predicate requires another noun. The Object, like the Subject, is always a noun, or word or words which will represent one. And the student in grammar will at once perceive that the difference between a Sentence *with* and *without an object* is the difference between a predicate consisting of a *transitive* or an *intransitive* verb.* The great difference between the nouns of Subject and Object is, that the *subject* must be in the *nominative* case, the *object* in one of the two *objective* cases, the direct or indirect (accusative or dative). See § 152.

(*a*) *Subject.*—The simple subject may be one of the following:—

	Subject.	*Predicate.*
Noun	*Woman*	is weak.
Pronoun . . .	*She*	is weak.
Adj. as noun . .	*The weak*	suffer.
Verbal noun . .	*Suffering*	is painful.
Infinitive mood .	*To suffer*	is painful.

The Object may also be any of these parts of speech.

(*b*) *Enlargement.*—The Subject, and also the Object, may be *enlarged* by the addition of words to qualify its meaning. These are called *attributes* (as was shown in *Syntax*, § 231), of which there are four principal kinds:—

1. Adjective: *Sweet* apples abound,
A fine large house is useful.

2. Noun in apposition: *Jumbo, the elephant*, will not stir.

3. Noun or pronoun in possessive case: *Mother's* dog is wounded; *my* sight is gone.

4. Adjective-phrase: A row *on the river* is delightful; want *of truth* disgraces you; his intention *to leap* [dative infinitive] was apparent.

5. A fifth means is Enlargement by Sentence: *That he is quite wrong* is self-evident.

But *note* that, by making the subject into a sentence, we get two finite verbs and a complex sentence. Nevertheless, we must here consider the form of the *noun-sentence*—it is the whole proposition "that-he-is-quite-wrong" which acts as Subject. Again with the Object:—

1. Dogs eat *bad* meat.
2. Men eat bread, *the staff* of life.
3. Dogs eat *bullocks'* flesh.
4. Dogs eat meat *with eagerness.*
5. Dogs eat *that which is bad.*

Here it is "that-which-is-bad" that is eaten. Enlargement of Subject or Object into a sentence is always introduced by a relative pronoun or adverb.

(*c*) *Predicate.*—As additional words to the Subject are termed enlargement, so words added to the predicate are called *Extensions;* they are either adverbs, or words that take the place of adverbs.

	Subject.	*Predicate.*
1. Adverb .	The child	writes *well.*
2. Adverbial phrase	The child	writes *with much ease.*
	He	weighs *four pounds.*
3. Adverbial sentence	The child	writes *as a child can write.*

* A few intransitive verbs take indirect objects. See (*d*) below.

These Extensions, affecting the predicate as adverbs affect verbs, may be classed, if it is thought well, just as adverbs are—according to *time, place, manner,* and *cause.*

The verb *to be* cannot of itself form a predicate, except where the idea of existence only is to be conveyed; it requires another word, adjective or adverb, to give the idea of the assertion—as "the knife *is sharp;*" "I *am here.*" These additional words are therefore not parsed as Extensions, but as part of the predicate itself: the verb really is, "to be sharp," "to be here," etc.

(*d*) *Object.*—Some transitive verbs have two objects—one direct, one indirect (see before, § 232, *a*) :—

Subj.	*Pred.*	*Object.*	
John	gave	*Mary* [ind.]	*a present* [dir.]
She	told	*him*	*a tale.*

The verb *make* takes two direct objects—"They made *her queen* of May." The infinitive mood, or a verbal noun, is often the second or indirect object after transitive verbs :—

Subj.	*Pred.*	*Object.*	
I	promised	her	*to go.*
We	heard	the wind	*blow.*
He	forced	him	*to wait.*
I	found	her	*waiting for me.*
John	saw	him	*eating his dinner.*

Some intransitive verbs, and verbs completed by an adjective, take an indirect object:—

She talks *of him;*
Are you ready *to jump?*
She is guilty *of murder.*

§ 245. *Examples of Simple Sentence.*—In parsing by analysis there are several methods of arrangement, but the most convenient, perhaps, is tabulation.

1. "A man of words and not of deeds
Is like a garden full of weeds."
Old rhyme.

Subject.	Enlargement of Subject.	Predicate.	Object.	Enlargement of Object.
Man	(1) A, (2) of words, (and) (3) not of deeds	Is like	garden [indirect]	(1) a, (2) full of weeds

And does not belong to the enlargement, but joins the terms (2) and (3), which are co-ordinate in their meaning, to the subject *man.* This use of *and* to join co-ordinates belonging to the same word will be found to be frequent.

2. "The emperor kept the watch in the midst of his brave men."—*Walker's Original.*

Subject.	Enlargement.	Predicate.	Extension.	Object.	Enlargement.
Emperor	the	kept	in the midst of his brave men [adverbial phrase]	watch [direct]	the

3. "They gave him notice to quit."

They	Subject.
gave	Predicate.
him	Object, indirect.
notice	Object, direct, *to quit* a gerundial infinitive, being enlargement of dir. obj.
to quit	

The following give examples of simple sentences for practice :—

"To eke out his scanty pay, Schiller conducted for some time a small weekly newspaper."—*Sime's Schiller.*

"A bird in the hand is worth two in the bush."
Proverb.

"Before beginning his new duties, Schiller spent some pleasant days at the home of his parents."—*Sime's Schiller.*

"Thy thrice noble cousin,
Harry Bolingbroke, doth humbly kiss thy hand."
Rich. II., Act iii., sc. 3.

"Men judge by the complexion of the sky
The state and inclination of the day."
Ibid., Act iii., sc. 2.

XL.

Ultra-Solarian Astronomy.

Hitherto we have dealt with the astronomy of the solar system, or at least with bodies coming within the confines of the solar system. Now we have to consider the astronomy of the remainder of the universe, as revealed by the stars, especially by the binary double stars and the nebulæ.

The first to be dealt with will be the stars, and particularly the double stars.

The total number of stars which can be ordinarily seen with the naked eye on a bright clear night is about two thousand in number, and the greater part of these are very faint. The actual number of stars which readily catch the eye on a bright, starlight night, do not amount to over six hundred. And

yet, when one surveys the heavens, the stars seem far too numerous to be numbered. As at any time only one-half of the entire heavens can be seen, it follows that the total number of stars that can be seen with unaided vision must be some four thousand in number—they are really nearly five thousand in number—but then the fainter stars, which lie near the horizon at any moment, cannot be seen with the naked eye, though they would be distinct enough if sufficiently far above the horizon to escape the dimming effects of the thin haze and cloud always there,

Stars visible to the naked eye.

It has been already mentioned that astronomers divide the stars into different magnitudes, those of the first magnitude being the brightest, those of the second magnitude the next brightest, while those of the sixth magnitude are the faintest visible to the naked eye. But astronomers do not stop here, and the still fainter stars, only visible in a telescope, are similarly divided into stars of the seventh, eighth, ninth, and so on, magnitudes. Then the stars of each magnitude are subdivided into tenths of a magnitude, and so on. Thus stars of the 5th magnitude comprise all stars which are fainter than the 4·5 magnitude, but brighter than 5·5 magnitude.

Star magnitude.

It must be remarked, though, that some astronomers, instead of dividing stars into tenths of a magnitude, do so into only thirds, and in this manner: 4-5 or 5-4; by which they mean in the first case a star not so bright as a 4th, but not near so faint as a 5th, or about a $4\frac{1}{3}$rd: whilst in the second case is meant a star brighter than the 5th, but not near so bright as a 4th, or a $4\frac{2}{3}$rds. Sometimes the hyphen is replaced by a dot, or they are written 4.5 and 5.4, and it is then necessary to be careful not to confuse with a star of the 4·5 magnitude.

According to the standard scale of magnitudes, a star of any given magnitude—say the 5th—is $2\frac{1}{2}$ times as bright, or sends to us $2\frac{1}{2}$ times as much light, as a star of one magnitude less—say the 6th magnitude. And here it may be remarked that astronomers usually term a 6th magnitude star one of *less* magnitude than a 5th magnitude, and a 7th magntude as of less magnitude than a 6th magnitude star, and so on, whilst a star of the 4th magnitude would be said to be of *greater* magnitude; but on the other hand, they commonly refer to stars of the 6th and 7th magnitudes as being stars of *higher* magnitudes than those of the 5th. Then, taking a star of the 6th magnitude to be of unit brightness, the brightness of the stars of other magnitudes will be :—

Difference in light.

1st mag.	$= 100$	7th mag.	$= \frac{2}{5}$
2nd ,,	$= 40$	8th ,,	$= \frac{1}{6}$
3rd ,,	$= 16$	9th ,,	$= \frac{1}{16}$
4th ,,	$= 6\frac{1}{4}$	10th ,,	$= \frac{1}{40}$
5th ,,	$= 2\frac{1}{2}$	11th ,,	$= \frac{1}{100}$
6th ,,	$= 1$	12th ,,	$= \frac{1}{250}$

These refer to *standard* magnitudes, so called because they are reckoned on the scale which is gradually being introduced and accepted as a standard amongst astronomers. It is practically coincident with the scale used by Argelander in his great survey of the heavens. But there are other scales of magnitude in common use, which somewhat differ from these. Up to stars of the 9th magnitude these differences are not important, and all scales may be considered as very much alike; but for very faint telescopic stars some of the scales differ very materially. The principal of these scales may be said to be one adopted more or less uniformly by Herschel, Smyth, and Webb, and commonly called Smyth's scale and denoted by Sm.; the other is one used by Struve, and in a slightly amended form by his son Otto Struve; it is commonly denoted by Σ, a capital Greek Sigma. Both these scales are generally restricted to the companions of double stars. The following give an approximate comparison between these scales and the standard one :—

Different scales.

Standard Scale.	Smyth's Scale.	Struve's Scale.	Aperture.
10	10	$9\frac{1}{2}$	$1\frac{1}{2}$
$10\frac{1}{2}$	11	$9\frac{5}{6}$	2
11	12	$10\frac{1}{3}$	$2\frac{1}{2}$
$11\frac{1}{2}$	13	$10\frac{3}{4}$	$3\frac{1}{4}$
12	14	$11\frac{1}{3}$	4
$12\frac{1}{2}$	15	$11\frac{3}{4}$	5
13	16	$12\frac{1}{3}$	$6\frac{1}{2}$
$13\frac{1}{2}$	17	$12\frac{2}{3}$	8
14	18	$13\frac{1}{3}$	10
$14\frac{1}{2}$	19	$13\frac{2}{3}$	13
15	20	$14\frac{1}{4}$	16

Under the heading "aperture," there is given the smallest telescopic aperture which will under ordinary conditions, show a star of the given magnitude. Thus in a telescope of $6\frac{1}{2}$ inches aperture, as a general rule, no star will be visible which is less bright than a star of the 13th standard magnitude, or, what is the same thing, of the 16th magnitude according to Smyth. Under exceptionally favourable circumstances, or to exceptionally keen-eyed observers, it may just show a star of half a magnitude smaller, say $13\frac{1}{2}$ magnitude; but, on the other hand, as a rule no star of smaller magnitude than the $12\frac{1}{2}$ will be visible unless carefully looked for.

Stars visible in different telescopes.

All the stars in the northern hemisphere down to $9\frac{1}{2}$ magnitude have been observed and mapped by Argelander; and the numbers are as follows :—

Number of stars.

10	stars	between	1·0	mag. and	1·9 mag.
37	,,	,,	2·0	,,	2·9 ,,
128	,,	,,	3·0	,,	3·9 ,,
310	,,	,,	4·0	,,	4·9 ,,
1016	,,	,,	5·0	,,	5·9 ,,
4328	,,	,,	6·0	,,	6·9 ,,
13593	,,	,,	7·0	,,	7·9 ,,
57960	,,	,,	8·0	,,	8·9 ,,
237544	,,	,,	9·0	,,	9·5 ,,

And it has been calculated that there are in the entire heavens over two and a half million stars brighter than the 10th magnitude. So that though with the naked eye only some 5000 stars can be seen, yet with the aid

of the smallest telescope, little more powerful than an opera-glass, over 2,500,000 stars can be seen.

These stars are divided into constellations according to very ancient usage; the boundaries of these constellations being very vague.

Nomenclature. The brighter stars in these constellations are distinguished by the Greek letters α, β, γ. . . . Others, less important, are distinguished by English letters *a*, *b*, *c*, or by numbers, principally the numbers in Flamstead's catalogue of the stars. Others, again, are distinguished by the number they bear in other catalogues—as the great catalogue of the British Association, abbreviated into B.A.C. Amongst double stars the principal abbreviations are Σ for Struve's catalogue, and O Σ for Otto Struve's catalogue, and ℍ for Herschel's catalogue. P, with Roman figures, showing the hour of R.A., stands for Piazzi catalogue. The position of the stars in these constellations, and the position of the constellations themselves, can only be learned by comparing a good star atlas with the heavens, Proctor's star atlas being the best for this purpose.

We shall now proceed to speak of double stars, and shall give a list containing a selection of them which will prove of value to the student.

XLI.

THE COMMONWEALTH (*continued*).

TOWARDS the end of July 1651 Charles took the bold resolution of trying the fortune of war once more in England. He seems to have imagined that at his presence the country would rise in his favour. On the 31st of July he left Stirling, and began his march southward. By the 6th of August he was at Carlisle, and towards the end of the month the royal standard was flying at Worcester. Cromwell started in pursuit, leaving Monk in command in Scotland. On the 3rd of September, the anniversary of the battle of Dunbar, the last desperate struggle of the Civil War was fought out, and after six hours of fierce combat the Lord General had gained the triumph of which he was accustomed to speak as the "crowning mercy" vouchsafed to him. A statement by a writer of the day declares that Cromwell "did exceedingly hazard himself, riding up and down in the midst of the fire, riding himself in person to the enemy's foot to offer them quarter, whereto they returned no answer, but shot."

Charles in England; Battle of Worcester.

Charles became a fugitive, and went through a series of romantic adventures; at one time sheltered by the faithful brothers Penderell, at Boscobel, and hiding in an oak-tree from the pursuing soldiers; at another masquerading in the disguise of a servant; and, at last, indebted to trusty captain Tettersall for a passage from Shoreham, in Sussex, to France, while executions and sequestration punished those who had taken up his cause in England. Meanwhile Scotland was reduced to complete submission by General Monk.

Escape of Charles.

From this time Cromwell was everywhere acknowledged as the ruling spirit and dominating genius in England. From the day of the victory of Worcester he stood before the whole nation as the one man able to put down resistance in whatever quarter it might arise, and to whom all the jarring sects were compelled to bow in common submission. Already matters were preparing for the assumption of supreme power by the man especially fitted to wield it. The Act of Amnesty, issued early in 1652, for the pardoning of offences against the State, was an olive-branch which many former opponents were glad to seize; the measure increased the power of Cromwell and the dominant party.

Cromwell's power.

The passing of the Navigation Act, which deprived the Dutch of much of their carrying trade, by insisting that foreign goods might only be brought to England in British vessels, or in those of the country which produced them; the demand that Dutch vessels should salute the English flag, and other high-handed proceedings, led to a war with Holland. The Dutch sent Van Tromp into the Channel with forty ships, where he was encountered by Blake with twenty sail, in May 1652, to his manifest discomfiture, for he lost two ships.

Navigation Act.

In November, however, he succeeded in driving Blake, whose fleet was hardly half so large as his own, up the Channel and into the Thames, whereupon he displayed a broom at his masthead, in token of the clean sweep he had made of the English Channel fleet. But in the beginning of the next year Blake had been put at the head of an adequate force, and completely defeated the stout Dutch admiral, in February 1653, off Portland. The fortune of war thenceforward remained with the English; and Van Tromp, beaten off the North Foreland at the beginning of June, was killed in an action fought off the Texel, on July 31st. Penn, Monk, and Ascue distinguished themselves in this war, which terminated in an advantageous treaty for the English, in April 1654, one of the terms being the payment of £350,000 by the Dutch in satisfaction for a massacre perpetrated by them at Amboyna thirty years before; and the Navigation laws were upheld.

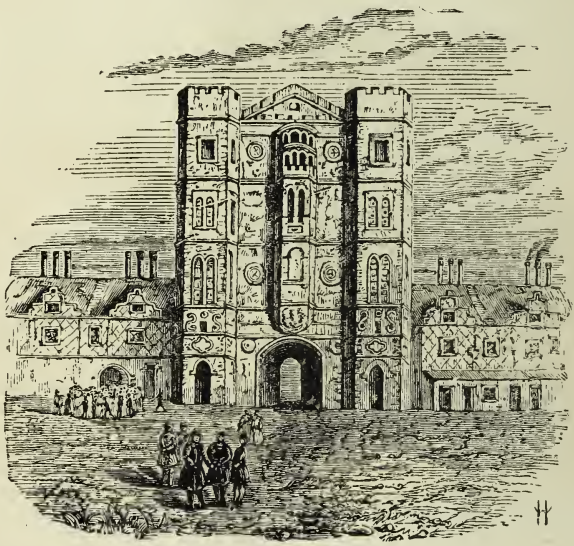
Blake and Van Tromp.

Naval triumphs.

The old quarrel between Presbyterians and Independents still continued. The parliament had determined to reduce the power of the army, and to strengthen itself by the recall of expelled Presbyterian members, who were to be considered as neutrals. Cromwell determined to anticipate a measure intended to destroy his influence and that of the party he represented. On the 19th of April he took counsel with his friends on the

Cromwell turns out the Rump Parliament.

question of the immediate dissolution of the parliament; and having decided on the step, proceeded with characteristic energy to put it into effect. He came down to the house "clad in plain black clothes and grey worsted stockings, and sat down, as he used to do, in an ordinary place." But presently he proceeded to bestow on the members a somewhat rhapsodical harangue, setting forth the various delinquencies and shortcomings of which they had been guilty; and, supported by a party of soldiers, turned Speaker Lenthall out of the chair and the members out of the house;—telling a trooper to take away "that bauble," the mace; and after making a clearance of the assembly, he went away from the house, locking the doors behind him, and carrying off the keys in his pocket. "Not a dog was heard to bark at their departure," was his subsequent comment on his own high-handed procedure. And now a new council of state was formed, consisting of twelve members besides himself; and a new parliament was called by them, an assembly limited in number, to which the nickname of Barebones Parliament has been applied, from the name of one of the members, the leather-seller Barbon, of Fleet Street. This Barebones Parliament did some useful things, and numbered some notable men, such as Howard, Monk, and Blake, among its members, though the fashion was for a long time to decry it as effete and despicable.



HOLBEIN'S GATE, WHITEHALL.

In December 1653 Cromwell assumed the office of Lord Protector of the Commonwealth of England, Scotland, and Ireland, an "instrument of government" being drawn up with forty-two articles, defining the conditions under which he exercised his power. He was to have a Council of twenty-one members to advise him, and a standing army of foot and horse, with triennial parliaments to make laws and levy taxes. The office of Protector was bestowed on Cromwell for life, but was not at first considered hereditary, the council having the power of appointing Oliver's successor.

Cromwell Protector.

The affairs of Ireland were for a time administered with justice and firmness by Henry Cromwell, the Protector's second son, who succeeded in improving the condition of the country, and gained the respect and attachment of many.

The new parliament did not answer the expectations of the Protector. It neither voted supplies nor made new laws, and was accordingly dissolved by Cromwell after having sat during just the five months prescribed by the instrument of government. Here, again, the Protector made use of the high-handed measure of stationing armed men at the doors of the house, to exclude such members as were opposed to his interests.

The new parliament dissolved.

Some of his discourses to the parliament are admirable in their lucid argument and plain good sense; and reference to the original speeches has shown the incorrectness of Smollett, the historian, who described him as "despicable in his discourse." He deprecated the idea of reducing all men to a common level, or abolishing distinctions of rank; but objected to the fashion, too prevalent among the cavaliers, of making profanity and licence a kind of badge of a gentleman. "We would keep up nobility and gentry," he said to his parliament, "and the way to keep them up is not to suffer them to be patronisers or countenancers of debauchery and disorders;—and you will hereby be as labourers in that work of keeping them up." He talked also of reformation as a thing upon which he was confident their lives and liberties depended. "Make it a shame to see men bold in sin and profaneness," he emphatically said, "and God will bless you. You will be a blessing to the nation; and by this will be more repairers of breaches than by anything in the world. Truly these things do respect the souls of men, and the spirits, which are the men. The mind is the man. If that be kept pure, a man signifies somewhat." These are great words, deserving to be remembered. There was some pathos in his speeches, too, as when he said, "I can say in the presence of God, in comparison with whom we are but like poor creeping ants on the earth—I would have been glad to have lived under my woodside, to have kept a flock of sheep, rather than undertaken such a government as this."

Cromwell's speeches.

BANKING AS A PROFESSION.

BY ROBERT SOMERS.

THE profession of banking, like good wine, requires no bush. It is not an occupation of life to be brought into notice, to have its advantages noised, or to be urged on the adoption of greater numbers of well-educated young men. The purpose of the present remarks must be, not to commend, but to guide the reader a little in the choice of a profession, and to state as nearly as possible the special qualifications requisite in the performance of bank duties, and thus likely to ensure competent reward and satisfaction in that department. There is probably no branch of business or way of life, indeed, more abundantly supplied with candidates for office. The profession is attractive to youths of nearly all classes of society — not only the middle classes of every rank, including the professional and literary orders, but of the nobility and gentry, and of the respectable working classes who make it a pride and honour to educate their sons. The banks may thus be said to be rather overcrowded with applicants for desks than in the slightest need of any increased supply; and it is sometimes argued not unreasonably that parents, and sons entering on business-life, are to blame for pressing so keenly into an easy and gentle profession, with the result of reducing the scale of remuneration and the chances of preferment, where there is no little of devoted service and other requirements exacted on the other hand; when, by taking a wider view of the new and advancing employments of contemporary progress, in rougher perhaps, but not less honourable fields of work and enterprise, much more advantageous results might be attained.

WESTMINSTER HALL AND ABBEY IN THE OLDEN TIME.

This is an evil, however, which comes to remedy itself in the natural action of society; and, in the case of banks, there are two special remedies, apart from the resources of employment within the banks themselves. In the first place, the entry into a bank office is an apprenticeship of a short term of years, every hour of which may be improved in knowledge and practice of accounts, and methods of conducting affairs, functionally related to every branch of business, whether merchandise, manufacture, or agriculture. A bank-clerk is thus free, after a limited period of time, to recast his future course, and sooner or later to enter for himself as a principal, or as an employed, into some department of many spheres of business, with a degree of capacity and hopefulness which he could not have better prepared for than in the bank. A bank apprenticeship, including even some extra years, is thus never lost time, unless the young man has lost or wasted it himself. In the second place, bank-clerks who have advanced much beyond apprenticeship, and acquired an established position as well as fully recognised character in the bank, though their progress in point of salary or formal place may not have been in any degree flourishing, yet have occasional outlets to larger office, undreamed of by themselves, and scarcely less surprising than the windfalls of a career of pure adventure, which theirs is not. A good deal of patronage in important financial concerns both at home and abroad naturally falls in the way of the banks; and though bankers, whether manager and directors, or private bankers directing their own affairs, do not much like to lose the services of an approved clerk of standing and experience, even though he may be but third or fourth in the list of advancement within the bank itself, yet it may be presumed that this is a patronage which the governors in the case dispense with due respect to the interests of their own tried and trusted *employés*. Having alluded to what may almost be called the rush for bank employment, it has seemed but proper thus to mention the subsequent outlets by which this pressure is in a measure relieved, and the supply more strictly conformed to the demand, with fairer and more adequate remuneration as the ultimate result. As for the general body of bank-clerks, there

is no class of officials in the kingdom, whether government or municipal, or of private firms, commercial or industrial, more uniformly distinguished by assiduity, regularity of service and conduct, and scrupulous integrity. The discipline of banking offices is generally so strict, and the *esprit de corps* so high, that order, attention, and full discharge of the day's business seem impressed on all from the first day of entrance. These traits, common but always consequential, are a part, as it were, of the bank atmosphere. They do not require so much to be enforced as inhaled ; and nothing can be well done without them to begin with.

And now, to come to what may be deemed some of the special qualifications for bank duties, it would be superfluous to dwell on such pre-acquirements as are of common necessity in all branches of commercial and financial business. With respect to the science of figures, it may be observed that besides what is called an aptitude for arithmetical computation, and not only an intimate knowledge of the formal rules by which results are worked out, but of the *reason* which governs every step of the rule, with its necessary strengthening of the reasoning faculty, a something more is particularly desirable on the part of a bank-clerk—viz., a clear and full comprehension of the important degree in which the smallest element of sum or amount affects the larger results. The profits of a banking company are made out of small shavings of rate ; and much of the most important business of banks involves not only fractions of pounds and smaller money, but many subdivisions of what is itself a fraction. Fractions and decimals thus preponderate largely in the arithmetic of the banks. There is depth as well as variety enough of subtle calculation in this arithmetic to engage a vast amount of study. The practice of experts has invented forms by which results are derived in a few seconds that might puzzle many a good arithmetical head for an hour. There are also printed books extended so minutely and vastly over complex combinations of figures, as to show at a glance results which could only be attained by much figuring. But every bank-clerk should aim at being himself an expert in the work he has to do, and prescribed methods of solution are never so readily applicable, or so satisfactory, as when accompanied by a thorough understanding of the underlying principles and *ratio*. Not unconnected with this subject is the power of concentrating attention, of waiving off all interruption of sound or vagary of thought, stronger in some minds than others, but capable of being cultivated in all. This is valuable in relieving the burden as well as in securing accuracy of work. Most bank work is done in company, much of it literally in public, and even in a bustle. The tellers, who operate at the counters, are seldom an object of envy to those whom they serve, and to whom the handling of money, with its risks of error or mistake, is a matter of constitutional dislike. The teller is under the task of being closely and minutely concentrative on the transaction in hand, while his eyes and ears are constantly summoned to attention by what is passing around him. But to all bank-clerks a power of abstracting themselves from immediate surroundings to their particular work—what is called a cool head, and power of steady application of mind till three columns of figures be summed, or a series of entries be made without spot or blemish, etc., etc.—is an important as well as necessary qualification. A nervous person, one easily distracted, shaken, or put out of sorts, would be out of place in many bank situations.

Another distinct faculty much called upon in banking offices, is what, since we are not aware that it has either been technically or literarily named before, may here be termed "scrutiny of documents." A bank-clerk has to make as early and full acquaintance as possible with many forms of document, used in various branches of business and for innumerable different purposes—some of general form and use, others specialised by the businesses in which they are employed. They are in a sense legal documents, or if not directly prescribed in terms of written law, documents which custom has made lawful and law-biding. Merchants and other business people know well the documents usual in their own sphere of transaction ; but a bank-clerk requires to know them all, as commonly used in the various divisions and subdivisions of commerce. All documents raising money pass into the banks, even post-office orders, little warrants for dividend on £10 of consols, and disposals of funds given *in articulo mortis*. Documents to be acted upon by the bank must consequently be correct and complete in their crucial particulars. Any intelligent business man, on being shown a monetary document the like of which he may never have seen before, would readily discover its general purport, and understand it in a certain degree. But the art of the bank-clerk extends much beyond this point. He is already familiar with its general form and purpose, and what he has to know is whether it is good in all the essential points. His eye is thus seen, far from wasting itself on dry laborious reading, to glance swiftly over certain star-centres within the four corners ; then he turns it over on the back and sees what is there ; and, turning as swiftly to the other side again, takes a final view of the essential facial features, in which it is found to be all right—or, in exceptional cases, subject to further judgment. This "scrutiny of documents" extends from bank-notes to every form of paper commanding or raising money in the banks, and there is no profession in which it is so much and so constantly exercised as in the banking profession, thus giving it largely the place of a distinctive professional faculty ;—nor is there any profession in which, as may be added, this faculty is exercised with less priggishness, less delay over mere formality, or with more accuracy, than in the banking offices.

When the bank-clerk has become accustomed to routine duties, and feels more at home, so to speak, under an enlarging sphere of work and responsibility, it will be his duty and his interest to comprehend more concretely, so as

to arrive at an enlightened *rationale* of all the wonderful phenomena and multiplied relations of the banks to the public passing under his eyes, and in a certain degree under his own workmanship. He will read the history of banking, and hear what veterans of the profession, heads of the Bank of England or of the equally ancient banks of Scotland, or such studious and observant bankers of comparatively recent times as Mr. Gilbart, and others now mostly his editors, have recorded of striking events in banking, frequently in the form of great disorders and calamities, the causes to which these were to be traced, and the means by which the remedial process put forth its strength again and again, and placed affairs in a more stable and prosperous position, because scientifically and practically somewhat better conformed to the natural principles involved in the whole drama of banking process. The questions of study that thus arise in the direct path of the bank-clerk are enough to make him a student, and a political and social economist not unprofound, for the remainder of his life. Unless he is to be ignorant of the tools with which he is working, he must know what Money is, what the difference is between Money and banking funds in general, as well as the intimate and mutually interlacing relations of the one to the other; he must discern how the reserve of money in the banks must be amply sufficient to meet all demands for money by depositors, discounters of bills, and other claimants of funds in the banks; he must distinguish between an inland current and a foreign current of money from the banks, and between the effect of a higher rate of discount in the principal markets abroad, and a lower rate at home, or *vice versâ*; he must understand, in short, that all proceedings within and outside the bank are an interchange of values, in commodities or stocks, of the balances of which as struck in the markets Money is the liquidation, and for which liquidation the banks, owing to their immense position as intermediaries, are primarily responsible. From this point the bank-clerk has to go on to the question—What is value? of what does it consist? and finds himself involved in the abstruse problems of political economy, as enunciated by many conflicting schools and nations. The value of a commodity that will keep it in reproduction and supply up to the demand, of course, is a return in exchange with other commodities equal to the cost of labour and other outlays in this particular production. But any State can depress the value of a commodity on one side of the frontier, and enhance it on the other, by simply imposing a heavy duty on its import; and this practice is still so general among the commercial nations that there is practically little exemplification yet extant of even the simplest and most elementary doctrines of economic science. Bankers and others have still to look through a misty action "as of trees walking;" and this department of knowledge, indeed, has come well-nigh to be deemed dry and unprofitable. One can scarce imagine anything so forbidding nowadays as to invite a young man to study political economy. Yet a bank-clerk who desires to understand all parts of his profession, and to see all round it, will assuredly not find economic studies barren of interest, but on the contrary edifying, more fascinating in proportion as the whole symmetry of doctrine is grasped, as well as most helpful and guiding were it in no more than the professional sense. There is one thing, however, which a bank-clerk cannot well be—he cannot be a bookworm, or a painful student of deep branches of learning. His profession primarily requires him to be a man of business and affairs; and the easy but diligent application of a prompt and vigorous mind, to such reading and study as may keep him abreast of the culture and intelligence of the age, is about as much as his professional duties will give him time and opportunity to cultivate. Advancement in the banks, so far as not proceeding on seniority, is probably more governed by the trust commanded in the branches of work already performed, and by the prudence and moderation of mind, and knowledge of people and character generally displayed, than by anything else. But when, in addition to the simple service-record and all requirements of manner, there is an obvious comprehension of the general principles of bank operations, of politico-economic philosophy, and of the public laws relating to financial and commercial transactions, a large weight is thereby thrown into the scale. It is culture of this kind that gives the highest possible tone.

The auxiliary studies important to bank *employés* may be pretty well accomplished by a course of systematic reading. But culture of this kind has been receiving of late years a great impulse from banking associations, of which the Institute of London Bankers is the most eminent, and indeed has already become no mean college in itself. The sessional readings of papers, discussions and lectures, embrace nearly every branch of study bearing directly on the interests of trade and banking, as well as many practical points of improved banking organisation and legislation, which give the labours of the Institute another "coign of vantage" in its action on public opinion, and its influence as a legislative force. The monthly *Journal* of the Institute must also be promoting effectively the same objects in the provincial centres of the kingdom. The banking *employés*, indeed, have much facility of association, owing to their proximity in large numbers throughout the chief towns; and this not only for the diffusion of professional, literary, and scientific culture, but for purposes of friendly and social insurance against the vicissitudes of life and health. Insurance funds among the clerks are common in the principal metropolitan banks. In these cases the directors or partners have usually laid the foundation in a grant of money, which the officials strengthen and sustain by regulated contributions. Besides the support and comfort afforded in numerous cases, not the least advantage, apart from actual relief, which may become either necessary or indifferent to the recipients, is the fellow-feeling and generosity of spirit fostered in the bank establishment.

ZOOLOGY.

XV.

The Cat Family (*continued*).

The Puma is the other great feline inhabitant of America, ranging farther north and south than the jaguar. It is compared to the lion because of its prevailing tint and the absence of well-marked spots; but it is much smaller, the body being little over three feet long, with a tail over two feet in length. It is more at home in the forests than the jaguar, and has been found at great mountain heights; its tree-climbing habits are not at all liked by its monkey neighbours. Cattle and horses form its chief prey, and it seldom attacks man. The pumas find that silence is golden, and seldom indulge in noisy

Puma.

cats, with diversities of habitat and food according to locality, all these exhibit a predominant cat-like nature, which often yields partially to domestication early in life, but is never quite quenched.

The Domestic Cat is evidently much modified from any particular species of wild cat. Most likely mankind at an early period of agricultural life found cats haunting his corn-stores and killing the rats and mice that infested them. The Biblical records do not help us to learn when the cat was domesticated, but we know that the Egyptians in very early times held cats in the greatest reverence, and preserved their mummies. The domestication of the cat must have been a great advance for the agriculturist; for in no other way can we imagine that human food-stores could have been preserved against the enormous power of multiplication possessed by mice and rats. In many districts traditions exist of the value set upon cats at their first introduction.

Origin of Domestic Cat.

CANADIAN LYNX. RACOON.

demonstrations; they are more like lynxes and wild cats in their expressions of sentiment when greatly provoked.

The Clouded Tiger of Further India and the Malay archipelago, and the Ocelot of Central America, bring us to the group called Tiger-cats: the clouded tiger, including its handsome and very long tail, attains a length of six feet; while the ocelot, with a much shorter tail, is but four feet in length. These creatures are very notable for their beauty, having many large irregularly-shaped dark patches marking the skin.

Every large tract of country appears to have one or more of the larger kinds of Wild Cats; some, like the Viverrine cat of India, living in marshy neighbourhoods, subsisting on fish and even shell-fish, others preying upon poultry or the smaller kinds of domestic cattle, others living on mice and small birds, others devoted to rabbits and hares. With varying proportions of tail and limbs, with differences of colouring many of which are exemplified in our domestic

Wild Cats.

The form of the cat is so well known that it would be useless to describe it, or to do more than mention, as to its faculties, its comparatively feeble sense of smell, its intense power of using every ray of light in the dark, by dilating the pupils of the eyes, its sensitiveness to sound, and the usefulness of its whiskers or tactile hairs, the bulbs of which are especially well supplied with nerves.

Main characters.

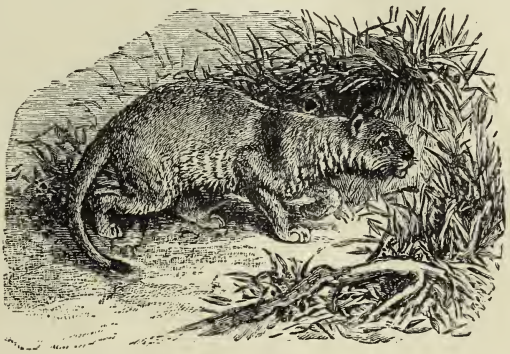
Cats can evidently live and breathe a long time underground. Supposed to have been killed, but in reality only stunned, then buried two feet deep and the earth stamped down over them, they have forced their way to the surface and gone about their business as if nothing had occurred. They are remarkably elastic, this quality almost absolutely preserving them from injury. So far as our experience goes, the wild-cat instinct is most deeply embedded in every domestic cat; provided the provocation is *sufficient* (a thing not always attainable), our quiet home-pet may

The wild beneath the tame.

be roused in a moment so as to assume the form, look, power, ferocity, rather the very devilry of aspect, of its wild original. We have seen quiet domestic cats so changed in a moment as not to be recognized by their friends. The head appears to flatten, the eyes grow larger, the ears lie back and elongate, the body dilates, the fur bristles. When in a fury of this description, the cat will stop at nothing: it will literally pass through fire when pursued by a dog. It will equally tear its young to pieces, not always to protect them from attacks, but sometimes as the result of an overpowering irritation which one would think had no connection with their offspring.

Cats are extraordinarily conservative, being attached to places rather than persons. They will sooner face starvation than leave the place in which they have lived for a number of years; and although people have often been blamed for leaving cats behind them, it is most frequently the case that the cats refuse to leave, or when taken away perforce, return of their own accord.

Conservatism of cats.



PUMA.

A cat, evidently having no settled home, came one morning on our window-sill, with a little kitten in her mouth, and cried. When we had taken in the little kitten, she went away, and in about an hour's time she brought another, and soon followed with a third. She disappeared, and never returned. This cat appeared to have some morality about her: she did not like to forsake the kittens, as many do, yet was satisfied to place them in human hands. Dogs have got beyond this stage; they would not thus be content to trust their offspring to humanity.

TIGER AND NYLGHAU.

A cat that had been born and had lived for some years at Newark, was given to a person at Nottingham, and taken in a basket by train. It remained only one night at the latter place, when it disappeared. About a week afterwards it appeared at its old home at Newark, looking very thin and miserable, and bearing one or two wound-marks, as evidence of the hazardous journey it had performed. This is sufficient to prove that some cats can find their way over unknown roads to places many miles distant.

Travelling unknown roads.

When cats are enraged, they behave much like tigers: they crouch with the body at full length, and they lash the tail from side to side. If about to fight, they show their teeth, put out the claws of their fore-feet, and prepare them for rapid striking. The cat when showing affection is extremely different: the tail is held straight up and stiff; she stands up, arches the back upwards, conceals her teeth, and with a purr rubs herself against her master or mistress. Some cats acquire habits of great affection towards other species; they have been known to suckle leverets and squirrels, and puppies.

Cats' demeanour.

The cats' fondness for fish and their dislike to wetting their feet are familiar as a proverb. Mice are their most universal food, although they like many kinds of flesh, and enjoy birds intensely. Under these circumstances the occasional formation of friendships between cats and pet birds is the more remarkable.

Cats' food.

Domestic cats do not show more than those differences which may be called variations. The Manx cat has a very short tail; the Persian cats are fine cats with long hair; the Angora cats are larger and usually covered with white hair. In China the cat is fattened for the table. The common varieties of tortoiseshell, tabby, and so forth, do not correspond with any known distinction in internal structure. They are universally found accompanying civilised man.

Varieties.

The Lynx is reputed to be the most destructive member of the carnivorous group left in Europe. It holds a position midway between the wild cats and the larger leopards, being three-and-a-half to four feet in length, and

having a short tail, and considerably longer legs in proportion than the cats in general. The face, in addition to the well-known piercing glance of the eyes, has a strong tuft of hair crowning the long ear-lobes, and a luxuriant growth of hair in the neck, chin, and sides of the face; so that there is quite enough to distinguish it for ferocious looks when angry. So much were some of the ancients impressed by its eyes, that they ascribed to them the power of seeing through solid bodies; and even now the epithet lynx-eyed, applied to an officer of justice, is considered a compliment.

The Lynx.

In many parts of Europe where the lynx was formerly well-known and abundant, he has become extinct; but he still roams in many of the central mountain and forest districts, and in Norway, Sweden, Russia, and in Siberia. Although he can hardly be said to be swift in pace, the lynx is as destructive as animals apparently much more powerful. His patience in lying in wait for his prey is perfect, for he gives no sign of his presence by movement or sound. Again, he can creep towards his game most stealthily and noiselessly, while his almost closed eye is exquisitely alert. His leaps are terribly sure, and his paws have a powerful stroke. He is no creature of one dish, but esteems highly any animal's warm blood. The reddish-grey skin, variously spotted, is much valued.

Destructive and stealthy.

The smaller Pardine lynx is abundant in Spain. The Canadian lynx is well known in Canada and the Rocky Mountains; but has not such a bad character as the European common lynx. The Caracal is a smallish but savage lynx, occurring in Asia from Arabia to India and Thibet, and also in Africa.

As a hunting animal, however, the chief contribution from among the cat tribe is undoubtedly the Cheetah, or Hunting Leopard. It is an animal rather larger than the lynxes, and distinguished by the many black spots on its fawn-coloured skin.

The Cheetah.

The cheetah, in more than one variety or species, is found over large regions of Africa and south-west Asia. Its long legs, and the slender make of the hinder part of the body, confer upon it a most marvellous speed, which is almost like a bound, or even like the swift flight of a shot. Thus the cheetah is soon able to run down the fleetest antelope. Its prey is killed by a clutch at the throat, which soon extracts some of the blood it loves. Cheetahs are half-tamed, and trained to hunt, both in India and Africa. Even when taken quite young, and brought up in a house, they soon develop fierce instincts, so that we are not surprised to learn that men have been known to be dragged from their horses and killed by these creatures. Their claws are not such dreadful weapons as is the case with the other cats, being not very retractile; and they are notable for being among the few day-hunting cats, the pupils of the eyes being circular and not elliptical.

Speed.

Fierceness.

XLIII.

Study on the Regular Verbs.

Wir theilen oft ein Gefühl das wir
veerr ty'-len afft ine ge-fuel' dass veerr
nicht verſtehen. Der jetzige Beſitzer
nieht fer-stay'-en dare yet'-si-ehe be-zit'-zer
dieſes Landguts kaufte es zu einem
dee'-ses land'-goots kowf'-te ess tsoo i'-nem
hohen Preiſe und hat den Werth deſſelben
ho'-en pry'-ze unt hat dane vairrt des-zel'-ben
durch kluge Einrichtungen ſehr erhöht.
dooreh kloo'-ge ine'-rich-tung-en zayr er-hocht
Er hat wohl bemerkt daß die frühere
airr hat vole be-mairrkt' dass dee frue'-e-re
Art und Weiſe, ein Gut zu bebauen nicht
art unt vy'-ze ine goot tsoo be-bough-en nicht
für die jetzige Zeit und die neueren
fuer dee yet'-si-ehe tsite unt dee noi'-er-en
Verhältniſſe genügt. Sie werden
fer-helt'-nis-se ge-nuecht' zee vairr'-den
glauben, mein lieber Freund daß ich
glow'-ben mine lee'-ber froind dass ich
mich uber den guten Ausgang Ihres
mieh ue'-ber dane goot'-en owss'-gang ee'-res
Unternehmens herzlich gefreut habe.
un'-ter-nay'-mens hairts'-lieh ge-froit' ha'-be
Wir wollen hoffen daß das Glück auch in
veerr vol'-len hof'-fen dass dass glueh owch in
der zukunft Ihnen treu bleiben wird.
dare tsoo'-kunft ee'-nen troy bly'-ben veert
Ich glaube wir werden in dem Monate
ich glow-be veerr vair-den in dame moh'-nah-te
November eine Reiſe nach Deutſchland
no-vem'-berr i'-ne ry'-ze nach doitsh'-land
machen; es iſt zwar nicht die beſte
mach'-en ess ist tsvahr nicht dee best'-e
Jahreszeit zu einem ſolchen Unter-
yah'-res-tsite tsoo i'-nem zol'-chen un'-ter-
nehmen, aber ich meine wir werden
nay-men ah'-ber ich my'-ne veerr vair'-den
doch, bei leidlichem Wetter die Schönheiten
doch by lyde'-lieh-em vet'-ter dee shoen-hy'-ten
des Landes bewundern. Ich habe lange
dess land'-es be-vund'-ern ich ha'-be lang'-e
auf beſſere Zeiten gehofft und ich werde
owf bes'-se-re tsy'-ten ge-hofft' unt ich vairr'-de
ſtets hoffen obgleich die Ausſicht in
stayts hof'-fen op-glych' dee ows'-zieht in
dieſem Augenblick eine wenig erfreu-
dee'-zem ow'-gen-blik i'-ne vay'-nich er-froy'-
liche iſt. Es iſt nicht genug daß man
li-che ist ess ist nich ge-nooch' dass man
das Gute wünſcht; man muß auch ſuchen,
dass goo'-te vuensht man muss owch zoo'-chen
es durch Arbeit und Bemühungen zu
ess doorch arr'-bite unt be-muh'-ung-en tsoo
erreichen. Ich hatte lange geſucht, ohne
air-ry-chen ich hat'-te lang'-e ge-zoocht' oh'-ne

ein Haus zu finden, welches groß genug,
ine house tsoo fin'-den vell'-ches gross ge-nooch'
und doch nicht zu groß für mich war.
unt doch nicht tsoo gross fuer mich vahr
Würde man nicht denjenigen loben,
vuerr'-de man nicht dane'-yay-nich-en lo'-ben
der viele Jahre hindurch redlich für
dare feel'-e yah'-re hin-doorch rayd'-lich fuer
seine Familie gearbeitet hätte?
zy'-ne fah-mee'-lee-eh ge-arr'-by-tet het'-te
Und sollte man denjenigen nicht auch
unt zoll'-te man dane'-yay-ni-chen nicht owch
loben der für sein Vaterland, ohne
lo'-ben dare fuer zine fah'-terr-land oh'-ne
Lohn, mit großer Mühe und Sorgfalt ar-
lone mit gross'-er mue'-e unt zorg'-falt arr'-
beitet? Kurz vor dem Ende des eilften
by-t-: koorts fore dame en'-de des ellf'-ten
Jahrhunderts führten die Fürsten
yahr-hun'-derrts fuer'-ten dee fuerst'-en
Europas ihre Vasallen nach dem
oi-roh-pahs ee'-re vas-sal'-len nach dame
heiligen Lande um gegen die Ungläu-
hy'-lich-en land'-e um gay'-gen dee un-gloy'-
bigen zu kämpfen; das war der erste
bich-en tsoo kemp'-fen dass vahr dare airr'-ste
Kreuzzug. Das Vetter wird sich bald
kroits-tsooch dass vet'-ter veert zich balt
ändern denn das Ende des Jahres naht.
end'-ern denn dass en'-de dess yahr'-es naht
Der Herbstwind wird wehen, es wird
dare hairrbst'-vind veert vay'-en ess veert
regnen, und wann der Winter kommt,
raych'-nen unt vann dare vin'-ter kommt
wird es auch schneien und frieren. Es
veert ess owch shny'-en unt free'-ren ess
hat in der vergangenen Nacht stark
hat in dare fer-gang'-en-en nacht stark
gedonnert unt geblitzt; Ich dachte gestern
ge-don'-nert unt ge-blitst' ich dach'-te gest'-errn
es würde bald donnern. Meine Freundinn
ess vuerr'-de bald don'-nern my'-ne froind'-inn
redete oft von einem Besuche den sie
ray'-de-te offt fon i'-nem be-zoo'-che dane zee
ihrem Bruder in Amerika machen
ee'-rem broo'-der in ah-may'-ree-kah mach'-en
wollte; ob sie aber dieses Vorhaben
voll'-te op zee ah'-ber dee'-zes forc'-ha-ben
ausführen wird, ist zweifelhaft. Ich
owss'-fuch-ren veert ist tsvy'-fel-haft ich
glaube die Reise, würde ihr zu
glow'-be dee ry'-ze vuerr'-de eer tsoo
beschwerlich werden; sie hat sich zu
be-shvairr'-lich vairr'-den zee hat zich tsoo
sehr an ein ganz ruhiges Leben gewöhnt,
zayr an ine ganz roo'-ich-es lay'-ben ge-voehnt'
so etwas zu unternehmen.
zo et'-vass tsoo un'-ter-nay'-men

English Version for Correcting the above Study, and for Re-translation into German.

We often partake of a feeling that we do not understand. The present possessor of this landed estate bought it at a high price, and has much enhanced the value of it by wise arrangements. He has well observed that the former (earlier) method and fashion of cultivating (to cultivate) an estate does not suffice for the present time and the newer circumstances. You will believe, my dear friend, that I have heartily rejoiced at the good issue of your undertaking. We will hope that fortune also in the future will remain faithful to you. I believe we shall make a journey to Germany in the month of November. It is indeed not the best time of the year for such an undertaking; but I think we shall yet, with tolerable weather, admire the beauties of the country. I have long hoped for better times, and I shall always hope, although the prospect at this moment is not a (a little) joyful one. It is not enough that one wishes what is (the) good; one must also seek to attain it through work and efforts. I had sought long without finding a house which was large enough and yet not too large for me. Would one not praise him who had throughout many years worked honestly for his family? and should one not also praise him who without reward works with great trouble and carefulness for his fatherland? Shortly before the end of the eleventh century, the princes of Europe led their vassals to the Holy Land to fight against the unbelievers; that was the first crusade. The weather will soon change, for the end of the year approaches. The autumn wind will blow; it will rain; and when the winter comes it will also snow and freeze. It (has) thundered and lightened heavily in the past night. I thought yesterday it would soon thunder. My (female) friend spoke often of a visit she wished to pay (make) to her brother in America; but whether she will carry out this intention is doubtful. I believe the journey would be too wearisome for her; she has accustomed herself too much to a quite tranquil life to undertake such a thing.

The Regular Verbs in the Foregoing Study.

Infinitive. Imperfect. Past part.

theilen, *ich theilte, getheilt,* to divide, partake of.
kaufen, *ich kaufte, gekauft.* to buy.
erhöhen, *ich erhöhte, erhöht,* to heighten (lift up), enhance.
bemerken, *ich bemerkte, bemerkt,* to observe.
bebauen, *ich bebaute, bebaut,* to cultivate.
genügen, *ich genügte, genügt,* to suffice.
glauben, *ich glaubte, geglaubt,* to believe.
freuen, (sich) *ich freute mich, sich gefreut,* to rejoice (a reflective verb, literally I rejoice myself).
hoffen, *ich hoffte, gehofft,* to hope.
machen, *ich machte, gemacht,* to make.
bewundern, *ich bewunderte, bewundert,* to admire.
wünschen, *ich wünschte, gewünscht,* to wish.
suchen, *ich suchte, gesucht,* to seek.
erreichen, *ich erreichte, erreicht,* to reach, attain.
loben, *ich lobte, gelobt,* to praise.
arbeiten, *ich arbeitete, gearbeitet,* to work.
führen, *ich führte, geführt,* to lead.
kämpfen, *ich kämpfte, gekämpft,* to combat.

ändern, *ich änderte, geändert*, to change or alter.
wehen, *ich wehte, geweht*, to blow.
regnen, *regnete, geregnet*, to rain (impersonal).
ſchneien, *es schneite, geschneit*, to snow.
donnern, *es donnerte, gedonnert*, to thunder.
blitzen, *es blitzte, geblitzt*, to lighten.
reden, *ich redete, geredet*, to speak.
machen, *ich machte, gemacht*, to make.
ausführen, *ich führte aus, ausgeführt*, to carry out.
gewöhnen, *ich gewöhnte, gewöhnt*, to accustom.

XIV.

Equilibrium Examples (*continued*).

We have learnt, then, that if three forces be in equilibrium, they must be in one plane, and either meet in a point or be parallel. In the former alternative, the triangle of forces is at once applicable. In the latter case, one force must act in the opposite sense to the other two, and be equal to their sum (for instance, the forward pull on two traces must be equal to the back pull of the carriage). Moreover, the resultant moment of the three forces about any convenient point must be zero. It will only be needful to test this in the latter case.

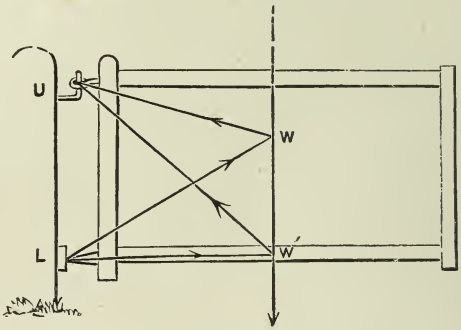


FIG. 33.

§ 63. We shall now give some examples which will illustrate the results just obtained, and will serve to indicate the method to be adopted in other instances.

Example 1. *A gate is supported by two hinges. Find the force exerted by each when the gate is at rest.*

Referring to fig. 33, let U represent the upper hinge, L the lower. Also, suppose the the weight-line of the gate to be W W′. This may be assumed to be found either by experiment or by other methods. The forces which act upon the gate are three in number—the stresses at the two hinges and the weight.

Gate.

For the moment we will assume that the force exerted by the lower hinge acts along the line L W. Then two of the forces pass through the point W, and, by the last section, the third force must pass through the same point, that is, it must act in the line U W. Having got the directions of the three forces, we can find their magnitudes by an application of the triangle of forces. In so doing, it will appear that each force acts in the sense indicated by the arrow-heads. The lower hinge pushes, the upper hinge pulls at the gate.

Now comes the question, how to find the place of W; and this is a question that cannot be answered unless we know something about the hinges. Two simple cases may be mentioned in which the question can be answered. Suppose the lower hinge, which is a thrusting hinge, consists merely of a horizontal pin in the gate, working against a plate on the gate-post. Then this cannot keep the gate up or press it down, consequently the stress at the lower hinge is horizontal, as shown by L W′ in the figure. The upper hinge may consist of a ring and hook; but since its pull is upwards (that is, along W′ U), the part fixed to the gate must rest upon the part fixed to the gate-post. If the hook were fixed to the gate-post and turned down, the hinge would be useless, and the gate would straightway slip down to the ground. If we wished to have a horizontal stress exerted at the upper hinge, we must have some arrangement different from that just ascribed to the lower hinge, since, as before noticed, one is a pulling the other a pushing hinge. If the upper hinge consists of a ring working on a staple along which the ring can slide up or down, it can exert no upward or downward pressure on the gate. The stress at U is then horizontal, and the lower hinge must be such as to press the gate upwards.

Although it is beyond the question under discussion, it may be interesting to point out some conclusions that can be drawn as to the construction of the gate. If the gate consisted merely of the four pieces shown in the sketch (fig. 33), it would soon lose its shape, the rigidity of the four corners not being sufficient to maintain the form. To avoid this, a diagonal piece may be inserted. If this diagonal is the one from the upper hinge, its office is to tie the gate, and the piece ought to be able to resist stretching. For instance, a wire, if strong enough, would answer the purpose. If, on the other hand, we wish to strengthen the gate along the other diagonal, a wire would be useless, however strong it might be. For this diagonal is one of thrust, and the piece ought to be one which cannot be easily compressed or bent.

§ 64. Example 2. *A ladder rests against a smooth wall. Determine the friction between the ladder and the ground.*

The figure for this case is given in fig. 34. A B is the ladder. The vertical line through W represents the weight-line. The pressure of the wall against the ladder acts along the horizontal line B W: for the wall, being "smooth," does not affect the motion of the ladder up and

down. Two of the forces pass through the point W. The third force, the pressure at A, must therefore pass through the same point: in other words, it must act along A W. If we know the weight of the ladder and the place of its weight-line, we can at once, by using the triangle of forces, determine how great are the pressures at A and B.

Ladder.

Now, if the ground were smooth, that is, if there were no friction between the ground and the ladder—a case that might be roughly realised by planting a ladder shod with iron on ice—the pressure at A would be straight up: and the more the force line A W leans towards the wall, the greater must be the friction. To find how great the friction is, we must resolve the force along the ground, and at right angles to it, by the process of § 49 (p. 379). The first of these components is the friction we seek. The reader will easily verify that A P represents the friction, on the same scale that W P represents the weight of the ladder.

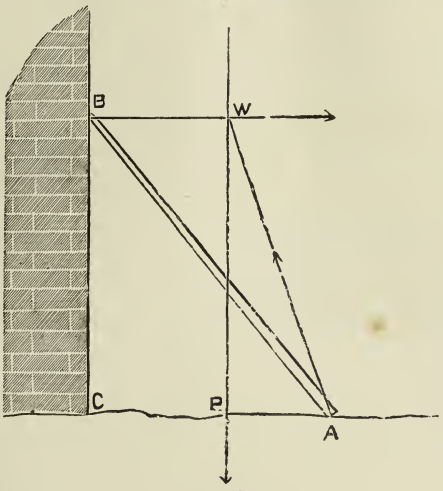


FIG. 34.

In the same way we can solve the problem when the ladder is kept from slipping by other means. If, for instance, the lower end is joined to the wall by a rope, or kept in place by the pressure of a man's foot, we can estimate the magnitude of the tension or pressure as soon as the direction of the force is given.

It is interesting to note that the friction or other restraint must be greater the nearer W is to the wall; for then A W leans more towards the wall. Suppose, now, a man is going up the ladder; then the weight-line of the man and ladder together moves towards the wall; and if the ladder is just on the point of slipping before the man begins his ascent, it will certainly slip before the man gets to the top. This statement admits of easy experimental proof, but the wise man will try it by deputy.

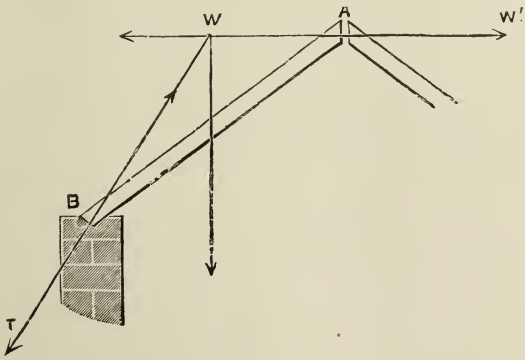


FIG. 35.

§ 65. Example 3. *Two beams are in contact at the top; their lower ends are supported by two walls. To find the conditions of equilibrium and the thrust on the walls.*

We suppose the beams to be resting in contact, as at A, fig. 35, the surfaces being smooth. The mutual action of the beams is then horizontal. Upon each beam there are three forces acting: the horizontal pressure, represented by A W, the weight acting down the weight-line through W, and the pressure of the wall. As the two other forces meet in W, the last must also pass through that point. Hence, the direction of the force exerted by the wall upon the beam is B W. By the triangle of forces we can now determine the magnitudes of the forces, knowing the weight of the beam A B. In just the same way the forces that keep the other beam at rest may be determined.

We have found the two horizontal pressures at A required to keep the two beams at rest. These two must be equal. This is one condition of equilibrium. The others are, that the walls must be sufficiently strong to give the pressure required at the lower ends of the beams.

The answer to the second part of the question is easily obtained. The thrust of the wall upon the beam B A acts along B W, and its magnitude has been found. The thrust of the beam upon the wall must be equal and opposite to this; because these two "thrusts" are, as we have already explained, really the same pressure regarded from different standpoints. The beams accordingly press downwards and outwards upon the walls. Now, walls, though capable of resisting a considerable pressure directly downwards, are not calculated to withstand much side-pressure. In the case of roofs, which is similar to the question here considered, it is needful to make provision for neutralizing the outward pressure upon the walls. This is usually done by tying either the walls or the lower ends of the principal rafters by means of a tie-rod. It is quite easy to find the tension in this rod, and the reader who has followed us thus far will have no great difficulty in applying a similar treatment to the simpler forms of roof-trusses.

Rafters.

The present example gives occasion to notice a very general source of error in dealing with mechanical problems in which several bodies are concerned. It is sometimes said—and the argument is developed in various manners which it is unnecessary to particularize—that the forces A W, A W′ are equal and opposite, therefore they balance each other, and may be neglected. At other times a difficulty is found as to the sense in which a force must be supposed to act. For instance, there may be a confusion as to whether we are to take the force A W or A W′. Now, these difficulties may be avoided by remembering which of the several bodies we are dealing with. To the question What are the forces that cut upon A B? the answer is without ambiguity. The doubt arises when one omits to specify which piece is under consideration.

XLII.

Division into Proportional Parts.

To divide a given number into proportional parts, means to divide it into parts which bear to each other the same ratio that certain given numbers bear to each other. Thus, to divide 15 into parts proportional to 1 and 4, would be to divide it into the parts 3 and 12, because $3 : 12 = 1 : 4$. And to divide 36 into parts proportional to 1, 3, and 5, would be to divide it into the parts 4, 12, and 20, because $4 : 12 = 1 : 3$, and $12 : 20 = 3 : 5$.

Example.—Divide £120 among A, B, C, so that their shares shall be in proportion to the numbers 2, 3, 7.

Here $2 + 3 + 7 = 12$, so that if we divide the £120 into 12 equal parts, and give 2 of these equal parts to A, 3 to B, and 7 to C, we shall have disposed of the whole £120, and the three shares will be $£\frac{120}{12} \times 2$, $£\frac{120}{12} \times 3$, and $£\frac{120}{12} \times 7$, or £20, £30, and £70.

The above example suggests the following rule. Divide the given quantity by the sum of the numbers which express the given ratios, and multiply the quotient by each of these numbers. The products will be the required parts.

Example.—Divide £135 among 3 persons so that their shares shall be proportional to $1\frac{1}{4}$, $2\frac{1}{2}$, and 3.

Following the rule, we have

$$1\tfrac{1}{4} + 2\tfrac{1}{2} + 3 = 6\tfrac{3}{4} = \tfrac{27}{4}$$
$$£135 \div \tfrac{27}{4} = £20.$$

∴ the shares are £25, £50, and £60.

It is generally better to use the integral numbers which are proportional to the given fractional numbers—*i.e.*, in this case 5, 10, 12. Then the shares are, by the rule, $£\frac{135}{27} \times 5$. $\frac{135}{27} \times 10$, and $\frac{135}{27} \times 12$. The theory of proportional parts, which is only a particular application of the Rule of Three, is chiefly useful in questions in Partnership.

Partnership or Fellowship.

There are two kinds of partnership—simple and compound. It is simple when the capital of each partner is invested for the same time. The profit or loss in this case is shared among the partners in proportion to the capital contributed by each. But if the capital is invested for different periods by the partners, the profit or loss ought to be shared in proportion to the *time* for which each partner invested, as well as in proportion to the *amount* of his capital.

Example 1.—A, B, and C subscribe to form a partnership. A invests £500, B £600, and C £900. At the end of a year they divide the profits, amounting to £70 10*s*. What does each get?

This is simple partnership, and is only a question of the division of £70 10*s*. into parts proportional to 5, 6, and 9. Now $5 + 6 + 9 = 20$, and £70 10*s*. $\div 20 =$ £3 10*s*. 6*d*.

∴ A gets £3 10*s*. 6*d*. × 5; B £3 10*s*. 6*d*. × 6; C £3 10*s*. 6*d*. × 9.

Example 2.—A and B invest £1000 each in a certain venture. At the end of 6 months they admit C, who puts in £1250, and in 6 months more they take D into partnership, who brings in £750. At the end of a year and 8 months they divide the profits, which amount to £1270. How much ought each of them to get?

A's £1000 was invested for 20 months, which is equivalent to £20,000 invested for 1 month.

B's £1000 was invested for 20 months, which is equivalent to £20,000 invested for 1 month.

C's £1,250 was invested for 14 months, which is equivalent to £17,500 invested for 1 month.

D's £750 was invested for 8 months, which is equivalent to £6000 invested for 1 month.

We see, thus, that we may suppose the partners to have contributed these sums of £20,000, £17,500, and £6,000 for the *same* period, viz. 1 month, and therefore our problem, originally compound, now becomes simple. It is in fact to divide £1270 in proportion to 20,000, 20,000, 17,500, and 6,000; or in proportion to 200, 200, 175, and 60. Applying the rule, we have

$$200 + 200 + 175 + 60 = 635$$
$$\text{A's share} = \tfrac{1270}{635} \times 200 = 400$$
$$\text{B's} \quad " \quad = \quad " \quad \times 200 = 400$$
$$\text{C's} \quad " \quad = \quad " \quad \times 175 = 350$$
$$\text{D's} \quad " \quad = \quad " \quad \times 60 = 120$$

The above process gives us the following rule:—Express all the *times* in the same denomination, and multiply each partner's capital by the time for which it is invested. The products are the equivalent capitals invested for the same period, and are therefore proportional to the required shares of the profit. The shares are found then by the rule for division into proportional parts.

Profit and Loss.

Questions in Profit and Loss depend on the rules of Proportion. We shall give a few examples of the statement of such questions.

Example 1.—I buy 1,200 eggs for £3 15*s*., and sell them at 11*d*. a dozen. What is my gain per cent. on the cost price?

£3 15*s.* = 75*s.* = 900*d.*

∴ 12 eggs cost 9*d.*

∴ on each dozen sold at 11*d.* there is a gain of 2*d.*

∴ total gain is 200*d.* = 16*s.* 8*d.*; *i.e.* 16*s.* 8*d.* is the gain on the cost price, £3 15*s.*

Hence to find gain per cent. we have,

£3 15*s.* : £100 :: 16*s.* 8*d.* : gain per £100.

Example 2.—A ton of sago is bought for £46 13*s.* 4*d.*, and sold so as to gain a profit of 15 per cent. At what price per lb. was it sold?

There is a gain of 15 per cent.; in other words, if the cost price be represented by 100, the selling price will be represented by 115. Hence,

100 : 115 :: cost price : selling price.

i.e., 100 : 115 :: £46 13*s.* 4*d.* : selling price per ton.

Example 3.—If a grocer buys tea at 3*s.* 6*d.* per lb., and sells it at a loss of 10 per cent., what price per lb. did he sell it for?

If the cost price be represented by 100, the selling price must be represented by 90. Hence

100 : 90 :: 3*s.* 6*d.* : selling price of 1 lb.

Example 4.—By selling a chair at £5 an upholsterer loses 8 per cent. At what price should he have sold it so as to gain 9 per cent.?

Let the cost price be represented by 100, then the actual selling price would be 100 − 8, *i.e.* 92, and the price which would have gained 9 per cent. would be 100 + 9, *i.e.* 109. Hence

92 : 109 :: £5 : required price.

ALLIGATION.

Questions relating to the price of mixtures composed of ingredients of different prices are solved by a method called Alligation.

Example.—Find the price of 1 lb. of a mixture composed of 3 lb. of tea at 2*s.* 6*d.* per lb., 2 of tea at 3*s.* per lb., and 1 of tea at 5*s.* per lb.

Here, 3 lb. of 1st sort cost 7*s.* 6*d.*

2 ,, 2nd ,, 6*s.*

1 ,, 3rd ,, 5*s.*

∴ 6 ,, mixture cost 18*s.* 6*d.*

∴ 1 ,, ,, 18*s.* 6*d.* ÷ 6.

In examples of this kind, where the quantities and their prices are given, and it is required to find the price of the mixture, the rule is:—*Express all the quantities in the same denomination, and multiply each by the corresponding price. Add together all the products, and divide the sum by the sum of the quantities.*

There is a much more difficult class of questions in Alligation, of which we shall now give some easy examples.

Example.—In what quantities must teas at 1*s.* 8*d.* and 2*s.* 5*d.* be mixed so that the mixture may be worth 2*s.* a lb.?

On every lb. of the 1*s.* 8*d.* tea used in the mixture there is a gain of 4*d.*

On every lb. of the 2*s.* 5*d.* tea used in the mixture there is a loss of 5*d.*

But clearly the loss must be equal to the gain in the mixture.

∴ there must be 5 lb. of 1st tea, and 4 lb. of 2nd, for then the gain is 5 × 4*d.*, and the loss 4 × 5*d.*

But suppose there is a 3rd kind of tea, price 1*s.* 10*d.*; how is the mixture to be made?

Here, if we mix the 1st and 2nd as before we get a mixture of those two kinds at the required price; and if we mix the 2nd and 3rd kinds, taking 2 lb. of the 2nd and 5 lb. of the 3rd, we have a mixture of these two kinds at the required price.

Then mixing these two mixtures we have a mixture containing 5 lb. of 1st tea, 6 lb. of 2nd, and 5 lb. of 3rd, and costing 2*s.* a lb.

This process may be shown in the following way:—

20
22
24
30

Arrange the given prices in order one below the other, placing the required price of the mixture, which we may call the mean price, to the left. Now, two of the prices are less than the mean, and one is greater.

From the reasoning above we see that we can make a mixture of the 1st and 3rd at the mean price, and also of the 2nd and 3rd at the mean price; and the sum of the two will give a mixture of all three kinds at the required price.

In the same way, if there be another ingredient at another price—say 40*d.*, we

20
22
24
30
40

can mix either of the prices above the mean with either of those below it. This is called "linking"—hence the name "alligation," which is the Latin equivalent for the same thing.

Suppose we link the 1st and 3rd, and then link the 2nd and 4th, and mix the two results, we have a mixture at the required price. Or we may link 1st and 4th together, and then 2nd and 3rd together.

As the number of ingredients becomes more numerous, the number of alternative ways of linking becomes greater too, but the principle remains the same.

Exercises in Proportional Parts, Partnership, Profit and Loss, and Alligation.

1. £500 prize money is to be divided between 2 sailors, a mate, and a captain. The sailors are each to get the same sum; the mate is to get as much as the 2 men; and the captain as much as the other 3 together. How much does each get?

2. Divide £1000 in parts proportional to the fractions $\frac{1}{2}$, $\frac{3}{5}$, $\frac{4}{7}$.

3. Three towns, whose populations are 3,000, 14,000, and 19,000, subscribed £144 to the famine fund in sums proportional to their populations. How much did each town subscribe?

4. The estate of a bankrupt, worth £842 2*s.*, has to be divided among his 3 creditors, A, B, and C. To A he owes £512 13*s.* 4*d.*, to B £407, and to C £283 6*s.* How much does each creditor get?

5. A and B go into partnership, A subscribing £100 and B £90. At the end of 4 months A withdraws one-fourth of his capital, and 2 months later B takes out one-third of his, while at the same time C is admitted with a capital of £140. The profits, 6 months later, are £508. How much do A, B, and C get each?

6. A and B together hire a field for the purpose of fattening their cattle on. A is to put

in 23 animals and keep them there 27 days. B is to put in 21 animals, and keep them 39 days. How much of the whole rent, which is £27, should each of them pay on settling their accounts?

7. Four gallons of whisky, costing 15*s.* a gallon, are mixed with an equal quantity of water, and one-fourth the quantity of an inferior spirit costing only 10*s.* a gallon. The mixture is sold in bottles holding one-sixth of a gallon each, at 2*s.* 10*d.* per bottle. What is the gain per cent. on the outlay?

8. A sells goods to B for £115 19*s.* 2*d.*, and gains 10 per cent. on the price he originally paid for them. B sells the same goods again, and loses 10 per cent. on the price at which he bought them. At what price did A buy the goods, and at what price did B sell them?

9. A tradesman's prices are 20 per cent. above cost price; if he allow a customer 10 per cent. on his bill, what profit does the tradesman in question make?

10. A man buys goods at £15 6*s.* 3*d.*, and sells them at £11 15*s.* $9\frac{3}{4}d.$ How much in that case does he lose per cent.?

11. A man buys goods at the rate of £24 per cwt., and sells 3 tons 13 cwt. 1 qr. for £2000. How much has he gained or lost per cent. by the transaction?

12. If 3 per cent. more be gained by selling a horse for £83 5*s.* than by selling him for £81, what must the original price have been of the horse?

13. How many lb. of tobacco at 5*s.* 3*d.* per lb. must a tobacconist mix with 4 lb. at 6*s.* 6*d.* that he may sell the mixture at 7*s.* 10*d.* per lb. and have the good fortune to gain $33\frac{1}{3}$ per cent. upon his outlay?

THEMISTOCLES.

14. A person buys an article, and sells it so as to gain 5 per cent. If he had bought it at 5 per cent. less and sold it for 1*s.* less, he would have gained 10 per cent. Find what would be the cost price.

15. An article for which a wholesale grocer paid 19 guineas per cwt. is retailed at 4*s.* 6*d.* per lb., there being a waste of 5 per cent. What is the rate of profit per cent. made in that case by the tradesman?

Answers.

1. £62 10*s.*; £62 10*s.*; £125; and £250. 2. £299 2*s.* $10\frac{3}{5}\frac{4}{9}d.$; £358 19*s.* $5\frac{3}{5}\frac{3}{9}d.$; £341 17*s.* $7\frac{1}{3}\frac{1}{9}d.$ 3. 12; 56; 76. 4. £358 17*s.* 4*d.*; £284 18*s.*: £198 6*s.* 8*d.* 5. £160; £90; £168. 6. £11 12*s.* $10\frac{1}{2}d.$; £15 7*s.* $1\frac{1}{2}d.$ 7. $118\frac{4}{7}$ per cent. 8. A bought at £105 8*s.* 4*d.*; B sold at £104 7*s.* 3*d.* 9. 8 per cent. 10. 23 per cent. 11. $13\frac{8}{7}\frac{7}{9}$ per cent. 12. £75. 13. 4 lb. 14. £6 3*s.* 15. 20 per cent.

ANCIENT HISTORY.

XXXVIII.

THE EMPIRE OF ATHENS.

FOR about thirty years after the repulse of the Persians, Athens adopted a vigorous foreign policy—a policy of aggression against her weaker neighbours, as well as of self-assertion against all comers—which, aided by the wonderful self-confidence inspired by her late victories, and by the great intellectual awakening of her people, made her during this time by far the most important of the Greek states, and in truth an imperial city, holding sway over most of the islands of the Ægean and over many Greek colonies.

Confederation of Delos.

The first step towards this end was the formation of a league called the Confederation of Delos, so named because the delegates met in the island of that name, and kept their treasure there. This league had Athens for its head. The Peloponnesian states still acknowledged Sparta as their head. The object of the league was to keep the Persians out of the Mediterranean. Each of the states joining it agreed to send so many ships fully equipped, or a certain sum of money instead, and Aristides was chosen by the states to fix the contributions of the several states. The payment of money in place of ships was a fatal mistake for the lesser states, as it soon came to be regarded by Athens as a tribute from her vassals, and the states could not protect themselves from Athenian injustice because they had no ships. Gradually the meeting of the delegates ceased, the treasure was removed from Delos to Athens, and a good deal of it used in paying Athenians to manage the business of the league, while some of it was probably spent in beautifying the town of Athens.

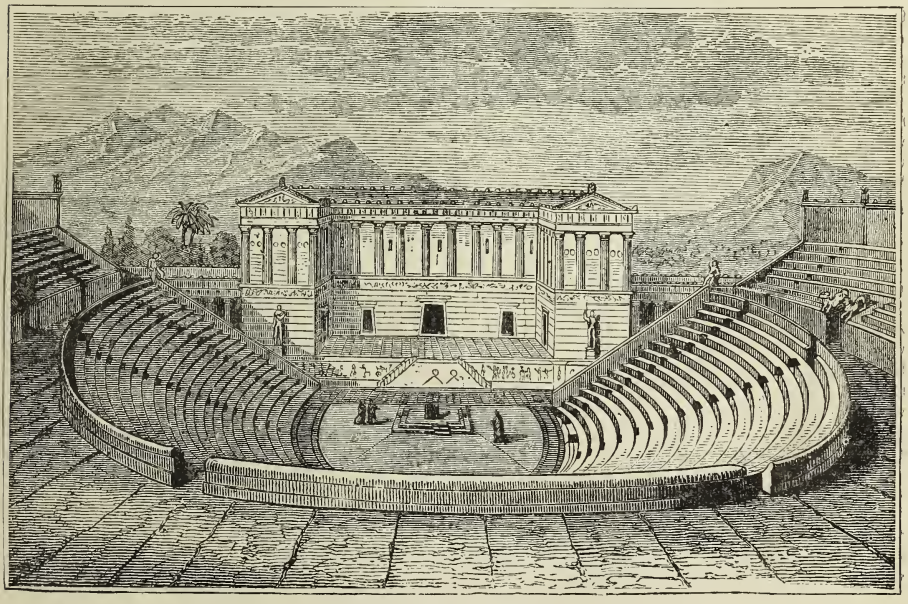
End of Themistokles.

Themistokles, like Miltiades, was unable to resist the temptation of using his great influence and power for private and unworthy ends, and in 471 B.C. was ostrakised, his great past services to the states probably saving him, as Miltiades had been saved, from a worse punishment. It was soon after found that he had been in treasonable correspondence with the Persians, and he was obliged to fly for his life from the country which he had once delivered from the Persians in her hour of deadly peril, and afterwards attempted to betray to that same Persia.

He made his way to Susa, the Persian capital, where he was received with great honours by Artaxerxes, the son of Xerxes, and in return he promised to do more for the benefit of Persia than he had ever done to injure her, though he boasted that he had done more in this respect than any man living. But he did not live to carry out his traitorous promises, and perhaps he never really meant to do so.

Democracy in Athens.

The great sacrifices which poor as well as rich had undergone equally, and the services which all had rendered equally to the state in the struggle against Persia, gave strength to the demand of the people to be admitted more fully to the privileges still restricted to the wealthy. Aristides was now, after the flight of Themistokles, the most powerful man in Athens; and although belonging to the party of the



THE THEATRE AT EGESTA.

rich, and indeed their trusted leader, he now proposed those changes for which he saw the country was ripe, much as he himself mistrusted them. All offices, including even the Archonship, were now opened to the poorest citizen. This was the last great public act of Aristides. He died in B.C. 468, and was succeeded in the leadership of his party by Kimon, son of the hero of Marathon. Kimon undertook an expedition to help the Spartans to quell a revolt of the Helots, but the Spartans suspecting treachery, sent the Athenians away. This insult enraged the Athenians against the Spartans, and against Kimon, who had wished to befriend them.

Perikles.

His rival, Perikles, the leader of the popular party, now gained the chief power, and kept it till his death, and Kimon was ostrakised. Perikles saw that Athens held a very different position in Greece and in the world since the Persian invasion. Up to that time she had been little, if at all, more powerful than many other Greek states. She had hardly any commerce, no naval power, little wealth. Her citizens were mostly small farmers. Now all was changed. She had two important seaports, thronged with shipping from all parts of the Mediterranean and Black Sea: she had the largest and most renowned navy of the time, and was at the head of a confederacy of the islands, which made her mistress of the Ægean, and her influence on the mainland was very great. Perikles determined to make all her citizens take part in the management of affairs, and thought he could make them fit to do so. He believed that by careful state education, and by encouraging the people to attend public meetings, and to act as jurors, and in all other ways to take an active part in carrying on their own state affairs, the poorest citizens would become as good public men as the richest, and fit to manage the affairs of their scattered empire. To enable poor men to do these things, the people, at Perikles' suggestion, passed a measure for paying citizens who attended the assembly or acted on juries. The veto on new laws possessed by the Areopagus was also taken away from that aristocratic body, so that the popular assembly was now absolute. Perikles believed that the people would become so intelligent that they could at least be trusted to follow wise statesmen in preference to ignorant demagogues. In this he was unfortunately mistaken. So long as he lived they did indeed follow him implicitly but after his death they gave too ready a hearing to loud-voiced ignorance, and the result was the com-

Changes in the constitution.

plete ruin of the noble empire Perikles left them.

But though they lost their material power, they did not lose the intellectual empire which Perikles may be said to have founded. In those days there was little schooling, as we have it. Books were very scarce and dear, as printing was, of course, unknown. Perikles tried rather to awaken the intellect and feelings of the people by making beautiful and noble the routine of daily life. Beautiful temples in which to worship, grand public buildings in which to transact public business, magnificent religious ceremonies, noble statues, pictures of soul-stirring events in history, tragedies to rouse their deepest emotions, comedies to make them quick and apt to see the humorous side of things—all these Perikles encouraged liberally. His efforts were crowned with the highest success which, perhaps, has ever attended similar efforts; and "the age of Perikles" is to this day spoken of as one of the most brilliant intellectual and artistic periods in the whole history of the world. It is certain that the statues and buildings and writings of that time which have come down to us have never been surpassed, if even they have ever been equalled. But we are anticipating somewhat.

"The age of Perikles."

Immediately after Perikles' accession to the chief power wars broke out all over Greece. The Athenians and their allies were successful everywhere, and for the moment even Sparta seemed afraid of her. But this supremacy of Athens did not last long. In B.C. 445 Athens was again threatened by a Spartan army, and had to buy her safety with a bribe. She then made a peace for thirty years with Sparta, by which she gave up all control over the states on the mainland, retaining only the island states. Perikles had now leisure to carry out those social reforms which we have already spoken of, and to encourage that intellectual development which forms the chief glory of "the age of Perikles."

But in B.C. 431 war broke out again. This war is known in history as "the Peloponnesian war," and it may be said to have led to the final ruin of the Greek states, preparing the way, as it did, for the conquest of all Greece by the Macedonians, who were succeeded by the Romans, with whose rule Greece ceased to have an independent existence, and became incorporated in the Roman empire. Twenty-seven years the Peloponnesian war raged, with only occasional truces for short periods, followed by fresh and more violent outbursts. It was carried on with the greatest barbarity, and fearful slaughter on all sides. Athenians vied with Spartans in taking bloody vengeance on all enemies who fell into their hands: they thought it quite right to massacre in cold blood thousands of defenceless men, women and children who had surrendered to them. But the worst feature of this miserable war was that almost every state was divided against itself, the people sympathising with democratic Athens, the nobles and the wealthy with aristocratic Sparta; and whichever party was in power for the time dragged the state into alliance with the side that party sympathised with, while the other party too often made common cause with the opposite side and used its aid to re-establish themselves by force of arms. In this way there was in almost every state in Greece a class war between rich and poor, leading to a series of bloody revolutions and counter-revolutions, besides the great war in which almost all the states were engaged, the one side led by Sparta, the other by Athens. The immediate result of the war was the humiliation of Athens and the ruin of her power, but in the final result all Greece shared the same fate. The Spartans had this advantage, that their allies were really independent allies, who when they joined Sparta did so of their own free will, whereas the allies of Athens were the members of the confederacy of Delos, who had now sunk into a condition of subjection to Athens, paying tribute to her, and following her of necessity and often grudgingly. Moreover, Sparta had an excellent war-cry in making it appear that they were fighting to rescue the subject cities from their tyrannical mistress Athens.

The Peloponnesian War.

XLII.

The Syntax of the Ablative Case (*continued*).

The Ablative of Origin.

The ablative of *origin* denotes that *from which* anything is made, or from which it originates—as in *Jove natus*, sprung from Jupiter.

The ablative follows such verbs as *consto*, I consist of, and such adjectives and participles as *genitus*, *natus*, *creatus*, begotten, born, created; *ortus*, sprung from—all, observe, denoting *origin;* or *ortus Saturno*, sprung from Saturn.

The Ablative of Cause, Manner, and Instrument.

The ablative case is used after verbs, participles, and adjectives, to denote the cause, manner, and instrument of an action or state of being—as in *Cornibus tauri se tutantur*, bulls defend themselves with their horns. Here *cornibus* is the ablative of the instrument, or manner in which bulls defend themselves.

The following adjectives take an ablative of the cause, as they express *feelings*: *contentus*, contented with; *dignus*, worthy; *indignus*, unworthy; *superbus*, proud of; *fretus*, confiding in; *lætus*, rejoicing in,—as in *Diligentia vestra semper fretus ero*, I will always rely on your diligence. Thus the adjective *fretus* is followed by the ablative of cause, as *diligence* in this case is the *cause* of the *confidence reposed*.

The Ablative of Quality.

The ablative of quality is used in the description of a person or thing, and always requires an adjective in agreement with it—as in *Cæsar traditur fuisse excelsâ statura, colore candido, teretibus membris*, Cæsar is said to have been (a man) of very tall stature, a fair complexion, and slender limbs. Observe all these ablative cases mark *quality*, and are all level with an *adjective* in agreement with the substantive.

The Ablative of Comparison.

The ablative of comparison is used after adjectives in the comparative degree instead of *quàm* with the nominative, and instead of *quàm* with the accusative of the subject in the construction of the accusative with the infinitive—as in *Tullus Hostilius Romulo* (i.e. *quàm Romulus*) *fuit ferocior*, Tullus Hostilius was more fierce (in war) than Romulus. Here *Romulo* is the ablative of comparison with the comparative adjective *ferocior*.

The Ablative of Time.

The answer to the question *when*, or at what particular point of time, is expressed by the ablative case without a preposition—as in *Solis occasu mortuus est*, he died at sunset. Hence we find the following terms in the ablative expression of *time*, used almost adverbially: *die*, by day; *nocte*, by night; *vespere*, in the evening; *tempore*, in season.

The answer to the question Within what time? is expressed by the ablative alone, or by the ablative with the preposition *in*—as in *Agamemnon vix decem annis unam cepit urbem*, Agamemnon with difficulty took one single city within ten years. The answer to the question, *How long before?* or *How long after?* is expressed by the ablative with *ante* or *post* after it. But the accusative may be used with *ante* or *post* preceding it. If the preposition is placed between the numeral and the substantive, either the ablative or accusative may be used. Thus all the following forms may be used with the same meaning:

Accusative.	*Ablative.*
Ante *or* post tres annos	tribus annis ante *or* post
,, ,, tertium annum	tertio anno ,, ,,
Tres ante *or* post annos	tribus ante *or* post annis
Tertium ante *or* post annum	tertio ante *or* post anno

When *ante* or *post* stands last, it may govern a preposition depending upon it—as ANNIS QUINGENTIS *et* DECEM POST *urbem conditam Livius fabulam dedit*, Livius brought forward a drama 510 years after the founding of the city.

Obs.—When *ante* or *post* is followed by *quàm* and a verb, the following constructions may be used:—Tribus annis post, quàm (or postquàm) venerat; Post tres annos quàm venerat; Tertio anno post, quàm (or postquàm) venerat; Post annum tertium quàm venerat. Or *post* may be omitted: Tertio anno quàm venerat.

All these expressions signify "Three years after that he had come."

The Ablative of Place.

The answer to the question *Where?* is put in the ablative case, sometimes with and sometimes without a preposition, if the name of the town or island be not of the first or second declension singular—as in *Tibure amo Romam*, when at Tibur (now Tivoli) I love Rome. But observe *Romæ*, at Rome; *Corinthi*, at Corinth; *domi*, at home; *humi*, on the ground; *militiæ*, at war. On the other hand, we have *dextra* (*manu*), on the right hand; *lævâ* (*manu*), on the left side; *bello*, in war; *terra marique*, by land and sea.

The following substantives—*locus*, *terra*, *regio*, *via*, *iter*—are frequently used in the ablative case without a preposition, when some attributive is attached to them—as *Aurelia via profectus est*, he set out on the Aurelian way.

Any substantive with the adjective, if it denote *place*, may be put into the ablative case without a *preposition*—as TOTA ASIA *fama ejus erat*, his fame was throughout all Asia.

Exercises.

Translate into English:—

Quis locus toto mari aut tota terra tutus erit? Silvisque agrisque viisque corpora fœda jacent. Tota Italia nihil præter bellum annos decem fuit. Hi nostri milites loco idoneo castra fecerunt. Læva intonuit, id quod nos magnopere delectabat. Terra mariquc Romani hostes vicerunt. Abhinc decem diebus fuit. Senatus Romanus decrevit ut legati Jugurthæ in diebus proximis decem Italia decederent. Plato uno et octogesimo anno scribens mortuus est. Hoc est Punicum bellum, quo nullum majus Romani unquam gessere. Nihil est otiosa senectute jucundius. Paucis contentus sapiens vivit. Superba bello est hæc gens. Dignus erat servus multis pœnis et etiam gravibus. Sol cuncta sua luce illustrat et complet. Helvetii reliquos Gallos virtute præcedunt. Pavo pulchrior est tauro. Nihil jucundius est amicitiâ. Aiunt calorem frigore jucundiorem esse. Medici peritiores sunt poetis. Constat medicum peritiorem esse poetâ. Aurum vilius est amicitiâ. Amicitia melior est quàm aurum. Constat nihil melius esse quàm amicitiam.

Translate into Latin:—

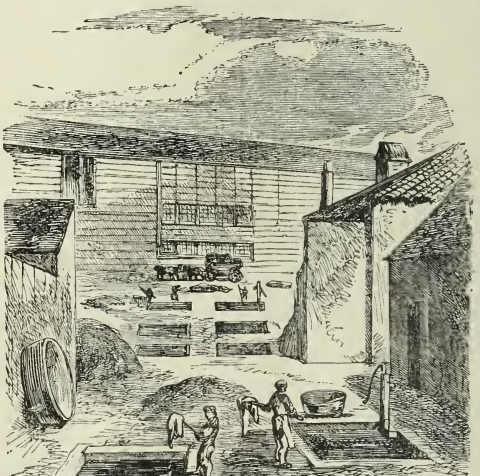
(Observe that *habitare* is to live at a *place*, not *vivere*, which is to live generally. *Cadiz* is *Gades*, *-ium*, *-ibus*.)

He is a man worthy of much praise. Are you content with these gifts of the consuls? He is unworthy of the confidence of the citizens. He made many and powerful friends by his constant and great kindness. Do not wars rest in winter? Next day Cæsar took the town by storm. At daybreak we shall set out. Within three days we shall fly from Athens. That man always lives in the country. Is Ennius at home? Catiline set out for the camp at midnight. Who was many years before Romulus? We shall go to Rome by the Appian way. Hannibal, being driven from Carthage, betook himself to King Antiochus. Many philosophers used to live at Athens. By this way we came to the citadel. Four years before they used to live at Cadiz. Did he remain at home or at Carthage? Do not sleep on the ground. They saved themselves by flight into the wood. Gold is more valuable

than silver, and silver than iron or brass. What is brighter than gold? Do not kill the birds with stones. They hate theft from a dread of punishment. Their food consists of milk, cheese, and flesh. In winter bears sleep in a cave. The cup was full of wine. The judge administered law with the highest equity. No greater conqueror than Cæsar ever existed.

Self-Examination Questions.

Give examples of the ablative of origin, the ablative of cause, manner, and instrument, the ablative of quality, the ablative of comparison, and the ablative of time and place. How do you account for any of these ablatives? How do you distinguish between *habitare*, to live, and *vivere*, to live? Write a sentence with each of these terms in it. Write out four sentences showing the usage of the ablative of time, and the ablative of place, the ablative of quality, and the ablative of comparison. When is time put in the ablative, and when in the accusative case? Write out examples in Latin of each construction. What substantives are frequently used in the ablative case without a preposition? When may a substantive with the adjective be put into the ablative case without a preposition? How is the answer to the question "Within what time?" expressed? How would you answer the question "How long before?" or "How long after?" What adjectives take an ablative of the cause?



TAN-YARD AND PITS.

CHEMISTRY

XL.

BREWING, ETC. (*continued*).—TANNING.

UNDER the head of brewing it may not be inopportune to say a few words concerning that domestic brew on a small scale of daily occurrence in most households: we mean the infusion of tea and coffee. What we commonly designate as tea consists of the duly manipulated and dried leaves of a shrub originally cultivated in China. A considerable proportion by weight—in the case of some teas more than one-half—consists of woody fibre wholly insoluble in water, the remaining portion being made up of vegetal extractive, tannin, etc., together with a vegetal alkaloid, the active principle of tea, to which the term theine is applied. This compound crystallizes in long white shining crystals, and is analogous in its structure to those alkaloid principles in other plants known as quinine, nicotine, morphine, etc., many of which are poisonous. Tea is always made as an infusion, —and it is essential, in order to extract the true flavouring principle of the leaves, that the water poured on them should be boiling. As a rule tea is left to draw, as it is termed, far too long. Five minutes is, in every case, amply sufficient to allow for the extraction of all that is good and wholesome in the tea. If the tea be left to stand for a longer period than this it will be found to contain too large a proportion of the dark-coloured, bitter extractive, and the astringent tannin. Tea should be of an amber colour, and give forth, when first poured out, an agreeable aroma. The dark-coloured opaque fluid that is kept constantly simmering, and to which fresh tea is added as required, and which is dispensed as tea at railway stations and refreshment bars, is not tea at all in the true sense of the term; it is neither wholesome nor palatable, holding, as it does, in solution a number of ingredients which good tea, properly made, should never contain.

The infusion of tea.

Constituents of tea.

Theine an alkaloid principle.

Boiling water an essential.

Time tea should draw.

Characteristics of good tea.

Why tea should not be left to stand.

Coffee may be made either as an infusion or a decoction, and it is still a disputed point among connoisseurs as to which is the better method of preparing this fragrant and agreeable beverage. The former is certainly the more extravagant method, as a larger portion of coffee is required when it is infused. Thus prepared coffee will be found to possess a possibly more fragrant aroma and delicate flavour, but one less full and decided than when it is boiled. The coffee berry contains more woody fibre than tea, together with a brown-coloured extractive soluble in water, gum, and resin in small quantities, and a fragrant essential oil. Coffeine, the vegetal principle of coffee, is analogous in its composition to theine. None who value a good cup of coffee

Coffee.

A decoction or an infusion.

Constituents of coffee.

will ever purchase their coffee ready ground. However carefully packed and kept, the volatile oil and other flavouring principles of the coffee are sure to evaporate. The berries should only be ground when intended for use, and care should be taken to have them ground sufficiently fine. In the East the berries are roasted immediately before they are ground or rather pulverized in a mortar, and sufficient water being added, the beverage is prepared by simply boiling; and coffee is produced in this homely fashion of an aroma and flavour such as is rarely met with on the most luxurious tables of western Europe. The art of making coffee is little understood in this country; and in the cabin of the French peasant coffee of a better quality is often made in an earthen pipkin than we find in houses of the wealthiest classes among ourselves. Coffee, if prepared as a decoction, should never be allowed to boil over. After being brought to a boil two or three times over a brisk fire it may be fined or cleared by pouring a portion alternately out of and back into the vessel in which it is made. Some persons use white of egg for this purpose, but we regard this as unnecessary, as the coffee after being manipulated in the above manner, if allowed to stand near the fire for a few minutes, will be found dark-coloured certainly, but perfectly clear and free from sediment. Neither tea nor coffee is wholesome if drunk cold. The precise quantity of milk or sugar to be added to tea or coffee varies of course with the taste of the individual. Some hold, with a considerable degree of plausibility, that neither milk nor sugar should ever be added to either. If milk be used, however, there can be no doubt that coffee requires a larger proportion than tea. In the French café-au-lait the quantity of boiling milk added to the coffee equals that of the latter.

Coffee to be ground when used.

Coffee making in the East.

Excellent coffee made by boiling.

How to boil coffee.

How to clear coffee.

Appearance of coffee thus made.

Cold tea and coffee.

Sugar and milk in coffee.

Café-au-lait.

TEA SHRUB.

COFFEE.

While on the subject of domestic cookery we may as well take the opportunity of saying a few words on the preparation of another beverage of great value in the sick room, which also goes by the name of tea,—we allude to the so-called beef-tea. The flesh of all animals contains in greater or less proportion the substance known as albumin. This compound, which is identical with white of egg, is met with in the blood and in the more nutritious or muscular portions of the flesh. White of egg, as is well known, coagulates or solidifies on being placed in boiling water. The fact is that albumin is partly soluble in cold, but insoluble in boiling water. If the meat be introduced into boiling water, therefore, the albumin on the surface becoming coagulated prevents the extraction by the water of the more tasty and nutritious portions of the meat. To make good beef-tea the following directions should be followed. The raw beef, free from fat, should be chopped tolerably fine and left to soak for some time in as much water as will cover it—from a quarter to half an hour. The first process in the preparation of beef-tea is really effected by the cold water, in which a portion of the albumin is dissolved. The whole should then be gradually heated to boiling point, and after being allowed to simmer for a short time should be strained through a sieve after being seasoned to taste. Beef-tea thus prepared ought to contain all the nutritious principles of meat; which, after the clear broth has been strained from it, ought to be almost as tasteless as bran. If, on the other hand, we prepare meat for the table by boiling, a diametrically opposite course must be pursued. In this case we of course desire to preserve all the natural juices and nutritious properties of the meat in itself, and must therefore just reverse the process prescribed in the former case. The piece of meat it is intended to cook should be introduced into boiling water at once, and kept at boiling point for five or ten minutes, until the albumin has had time to coagulate. In this manner a coating is formed over the surface of the meat impermeable to the juices of the

Preparation of beef-tea.

Albumin.

Where found.

Albumin soluble in cold water.

The first process.

When heat is to be applied.

Characteristics of good beef-tea.

The residuum of no value.

How to boil meat.

To be placed in boiling water.

Coagulation of albumin.

interior, by which they are therefore retained and not allowed to pass into the water. The boiling must now be stopped by the introduction of a considerable quantity of cold water, and the operation of cooking must be conducted more gradually, so as to insure the tenderness of the meat. In this way meat may be prepared by boiling almost as juicy and full flavoured as by roasting, and there is much less waste. The mention of albumin suggests another animal compound known as gelatine, of which we shall now proceed to give an account, in connection with

Internal juices preserved.

Subsequent process.

Gelatine.

The Process of Tanning.

Gelatine is a substance with which most persons are familiar in the form of isinglass, or in a more impure state as glue. It is the principal ingredient of all jellies. It is met with in almost every portion of the animal structure,—even in the bones, to which it imparts toughness and a certain degree of elasticity. Bone shavings and ivory dust, as well as the skins, tendons, and hoofs of animals, may be made to yield this substance. Ordinary gelatine as it is met with in the softer portions of animal structure, is readily soluable in boiling water, but when in combination with the earthy matter of the bones, phosphate and carbonate of lime, it requires the heat of a Papin's digester. This substance enters largely into the formation of the skins of all animals, and may therefore be regarded as the basis of leather: but before the skin can be converted into leather the gelatine it contains must have undergone a remarkable transformation, which is effected by a vegetal principle already spoken of as existing, associated with woody fibre, and known as tannin. Gelatine in its natural state is, as we have stated, partially or entirely soluble in hot water, and becomes soft and gelatinous in cold water. Boots and shoes made of untanned leather would therefore clearly be unfit for wear in wet weather. One important effect of the tannin on leather is to render the gelatine insoluble. If tannin or tannic acid be added to a solution of gelatine, the latter will be at once precipitated in the solid state. Tannin is an astringent vegetal principle met with in the bark of many trees, especially the oak. The gall nuts found on the leaves of that tree are rich in tannic acid.

As isinglass or glue.

Found in animal structures.

Soluble in boiling water.

Bones require a Papin's digester.

Gelatine in skins.

Change effected by tannin.

Untanned leather unfit for wear.

Effect of tannin.

Nature of tannin.

The skins of animals in their natural state absorb water, become gelatinous and semi-transparent, and if left in this condition would soon become putrescent and undergo decomposition. The skin or hide of any animal, if cut through, presents no appearance of the fibrous and almost felted appearance of leather; the fibres, indeed, are there, but they are invisible except to very close scrutiny. Leather, on the other hand, is insoluble in water, tough, opaque, fibrous, and non-putrescent.

Skins in their natural state.

Appearance of untanned skin.

Leather.

Such are the important changes effected in the operation of tanning. The following is a brief account of the entire process. The first operation consists in removing the hair from the skin or hide. This is effected by scraping with a kind of blunt, two-handled knife, after the hair has been loosened by steeping in lime-water. The use of lime as a depilatory is however attended with many disadvantages, which have to be overcome as far as is possible by a subsequent treatment of the skin. Further, to facilitate the operation of tanning, and to render the skins more permeable to the tannic solution, they are steeped for some time in a diluted acid: this process is technically known as "raising." The skins are now ready for the final operation of tanning, which is effected by steeping them for a considerable time, varying of course with the strength of the solution and the thickness of the skin, in pits filled with a solution of tannin obtained from the bark of the oak, ground to small fragments in a mill, or from that of some other tree. The leaves, buds, and small twigs of the sumach, growing in southern Europe, are rich in tannic acid, and are often made use of in the operation of tanning. The agreeable scent of Russia and Morocco leather is due to certain aromatic principles in the bark or leaves of the shrub employed in tanning. The manufacture of leather is a lengthy process, occupying weeks and even months. Many attempts have been made to expedite the process, but generally with the result of producing an inferior leather. To ascertain whether the skin has been converted into leather, it is cut through with a sharp knife from time to time. If the central portion of the section present a white or colourless appearance, the process has not yet been consummated. It will be seen from the above brief account that the tanning of leather is from beginning to end a chemical operation, whereby the gelatine is converted into tannate of gelatine or tannic gelatine. In addition to the property of rendering gelatine insoluble, tannic acid combines with the ferric compounds to form the black fluid known as ink. Black ink is chemically speaking pertannate of iron suspended in water.

Removal of hair from hide.

Lime as a depilatory.

Raising the skins.

The operation of tanning.

Oak bark and sumach.

Russia and Morocco leather.

Attempts to shorten the operation of tanning.

Completion of process.

Tanning a chemical operation.

Nature of ink.

The hydro-carbon compounds have been shown to belong to the domain of organic chemistry. We have already given an account of the more important hydro-carbon com-

pounds evolved in the manufacture of coal gas. The number of such compounds is in reality very great, and an enumeration of a few of the better known is sufficient for our purpose. Some of these bodies are fluid and some solid, and may be distilled from coal, shale, petroleum, and other quasi-organic substances. Naphtha, camphine, benzoline, naphthaline, paraffine, belong to this class. We propose to say a few words about the two latter—naphthaline and paraffine. The former of these hydro-carbons is a solid substance formed in the operation of making coal gas. Being very volatile, it often condenses in the cold metal pipes through which the coal gas is conveyed under ground, and gives rise to inconvenient stoppages. It is of a brown colour, but may be sublimed and condensed into white crystalline plates. On account of the immense preponderance of carbon in its constitution it requires an enormous amount of oxygen for its perfect combustion; that contained in ordinary atmospheric air being wholly inadequate for that purpose. It consequently gives off dense black fumes in burning which consist of unchanged carbon.

Fluid or solid.

Paraffine, napthaline, etc.

Formation of naphthaline.

Appearance when crystalline.

Preponderance of carbon in its constitution.

Paraffine is a white crystalline solid obtained from purified paraffine oil at a low temperature, from which it is separated by filtration. Paraffine oil is obtained, like coal gas, by the destructive distillation of coal in retorts. In fact, paraffine may almost be regarded as coal gas in the solid state. Paraffine cannot be employed alone in the manufacture of candles, but requires to be diluted with an admixture of wax, spermaceti, or other fatty compounds.

Preparation of paraffine.

Paraffine candles.

VIII.

SWEDEN AND NORWAY.

THE kingdoms of Sweden and Norway, which are united under one sovereign, occupy between them the whole of the north-western peninsula of Europe, commonly called Scandinavia. They are situated between lat. 55° 20′ and 71° N., and long. 4° 50′ and 31° E., and are bounded, north by the Arctic Ocean, west by the Atlantic Ocean, south by the Skager Rack, the Cattegat, and the Baltic, and east by the Baltic, the Gulf of Bothnia, and Russia. The length from north to south is nearly 1200 miles, and the greatest breadth 450. Area, 293,750 square miles, of which Sweden has 170,930, and Norway 122,820. Population (1880): Sweden 4,578,901, Norway 1,904,000; total 6,482,901.

The peninsula is traversed through its entire length by a great mountain range called the Scandinavian Alps, Dovrefeld, or Dofrines, separating Norway and Sweden. They are not so much a distinct mountain chain as a collection of broad plateaux, generally more or less connected together, though occasionally separated by deep valleys, and have a general elevation of 3000 to 6000 feet, some of their summits rising to over 8000. This mountain backbone lies much nearer the Atlantic than the Baltic coast, giving to Norway a rugged and alpine character, while Sweden is generally low and flat, except towards the mountains, where it rises in a succession of terraces. The coasts of Sweden are generally low and sandy, while those of Norway are bold, rocky, and deeply indented by firths or *fiords*, and fringed with numerous islands. The interior of Norway is wild and picturesque, comprising rocky mountains and platcaux, separated by deep valleys or extensive lakes, with waterfalls, etc. The rivers of Norway are generally short and rapid, and of little use in navigation. The longest is the Glommen, which has a length of 250 miles. The lakes are numerous, and abound in fish. The climate is milder than in any other parts within the same latitudes, and is less subject to the extremes of heat or cold, owing to the influence of the Gulf Stream, which strikes upon the coast. A great portion of Norway is covered with forests of pine, fir, birch, oak, elm, etc., which constitute its principal wealth. Only a small portion of the land is arable, the chief crops being barley, rye, oats, flax, hemp, and potatoes. In the mountain districts the rearing of cattle constitutes the chief occupation of the people. Along the coasts the inhabitants depend mostly on the fisheries. The chief mineral products are iron, copper, silver, lead, cobalt, and arsenic. The manufactures are mostly domestic, and the principal articles of export are fish and timber. In 1880 the imports valued £8,329,336, exports £6,003,300.

Sweden comprises the eastern and larger portion of the peninsula. The surface generally is flat, with a gradual rise towards the mountains on its western frontier. The southern portion consists of vast sandy plains interspersed with numerous lakes. The coasts are generally low and sandy, indented by numerous bays and inlets, and skirted by numerous islands. The country is well watered by numerous rivers and streams, but they are mostly all of small size, the longest being the Tornea, 290 miles in length, separating Sweden from Russia. The lakes are numerous, the principal being the Wener, Wetter, and Maelar. The climate is drier but more severe than that of Norway. In the south it resembles that of northern Germany, but in the northern parts snow and ice last for six months in the year. The soil is not generally fertile, but is well cultivated, and yields a considerable quantity of corn for exportation. The principal crops are wheat, rye, barley, oats, buckwheat, peas, beans, potatoes, hemp, flax, tobacco. There are also large forests of pine, fir, birch, lime, ash, elm, oak. Sweden is rich in minerals, especially iron, which is found in many parts. Copper,

lead, cobalt, silver and gold in small quantities, are also found. The manufactures are woollen, linen, and cotton stuffs, leather, paper, tobacco, earthenware, cast-iron, beer and brandy. Ship and boat building is also carried on. Imports (1879), £12,501,485; exports, £10,277,803. The Göta canal unites the river Göta with lakes Wener and Wetter, and so connects the Cattegat with the Baltic. Sweden has 3647, and Norway 820 miles of railway.

The executive power is vested in the king, and in Sweden the legislative power is exercised by the two chambers of the National Diet, the members of both of which are elected by the people. Norway, which previous to 1814 was united to Denmark, has its own constitution and laws, the will of the people being expressed by the *Storthing* or Great Council, which is composed of an upper and a lower chamber. Almost all the inhabitants are Lutherans, but toleration is extended to the other sects. Education is widely diffused among all classes.

Sweden: revenue and expenditure, each £4,192,410; debt, £11,717,583; permanent army, 35,406; navy, 141 vessels of all kinds, 373 guns, and 5204 men. Norway: revenue, £2,689,805, expenditure, £2,440,871; debt, £5,051,562; regular army, 18,000; navy, 123 vessels of every class, and 298 guns. The capital of Sweden is Stockholm, with 174,433 inhabitants; of Norway, Christiania, with 119,407 inhabitants.

SPAIN.

SPAIN occupies the greater part of the Iberian peninsula, in the south-west of Europe, lying between lat. 36° and 43° 45′ N., and long. 3° 20′ E., and 9° 20′ W., and bounded north by the Bay of Biscay and France, east and south by the Mediterranean, and west by the Atlantic Ocean and Portugal. Its greatest length from east to west is about 650, and its greatest breadth 550 miles. Area, 191,310 square miles. Population (1877) 16,053,961. Chief towns: Madrid, 397,690; Barcelona, 243,406; Valencia, 143,856; Seville, 133,938.

The whole country may be described as an elevated plateau or table-land, averaging from 2000 to 3000 feet above the sea. It is traversed from west to east by five principal mountain chains. The most northern of these is the Pyrenees, with the Asturian and Cantabrian mountains. South of the valleys of the Douro and Ebro are the Castilian mountains. The third chain comprises the mountains of Toledo, between the basins of the Tagus and Guadiana. The Sierra Morena forms the watershed between the Guadiana and the Guadalquivir. The Sierra Nevada, the most southern range, contains the highest point in the peninsula, the Cerro Mulhacen, 11,661 feet high. Spain possesses numerous rivers, some of which are of large size. The largest flow westward into the Atlantic: as the Douro, 500 miles in length; Tagus, 540; Guadiana, 400, Guadalquivir, 320. The largest river flowing eastward into the Mediterranean is the Ebro, 400 miles in length. There are no lakes of considerable size, but swamps and marshes are common. Spain is rich in minerals, the principal of which are coal, iron, lead, copper, silver, quicksilver, zinc, tin and gold in small quantities. The climate varies greatly in different parts, owing to position, elevation, etc. On the north and west coasts westerly winds prevail, and rain and fogs are frequent in winter and spring. The central portion is exposed to great heat in summer and cold in winter, but spring and autumn are pleasant. On the Mediterranean coast the temperature is very hot in summer and mild in winter. The soil is generally fertile, except in the elevated and parched districts in the centre, where there are large tracts of sandy waste. The chief crops are wheat, maize, barley, rice, hemp, and flax. Among the other products are cotton, the sugar cane, madder, saffron, cucumbers, melons, almonds, figs, pomegranates, lemons, oranges, dates, and olives. The vine is extensively cultivated. The resources of the country, however, owing to its long unsettled state, are not well developed, and the manufactures are inconsiderable. The principal exports are wine, olive oil, brandy, fruits, vegetables, grain, seeds, wool, silk, iron ore, quicksilver, cork; imports, colonial goods, cotton, woollen and silk fabrics, hardware, machinery, dried fish. Total value of exports, £20,637,045; imports, £21,534,317. The trade is mostly with Great Britain and France, about one-third of the whole being with the former. The government is a constitutional representative monarchy, the legislative power being vested in the king and the Cortes, which is composed of two chambers,—the Senate and House of Representatives. The established religion is the Roman Catholic, and education is very much neglected. Army, on peace footing, 80,000 men; navy, 121 vessels, carrying 525 guns. Revenue (1880), £30,484,147; expenditure, £32,669,419; public debt, £500,949,714.

PORTUGAL.

PORTUGAL occupies the south-western portion of the Iberian Peninsula, being bounded on the north and east by Spain and south and west by the Atlantic Ocean. Its length from north to south is 356 miles, and its greatest breadth 153. The coast-line is about 500 miles in extent, and contains many excellent harbours. The general configuration of the country resembles that of Spain, and all its great rivers and mountain chains originate in the latter country. The principal rivers are the Minho, Douro, Tagus, and Guadiana. The climate resembles that of Spain, and is in general healthy. The soil is naturally fertile, but agriculture is in a very backward state. The principal crops are wheat, barley, oats, rye, hemp, flax, maize, rice. The chief fruits are olives, oranges, figs, almonds. The vine is extensively cultivated, and the well-known port wine takes its name from the city of Oporto, where it is shipped. The mineral wealth is considerable, but has been little developed. It includes coal, iron, salt, copper, lead, tin, silver, antimony, marble, porcelain-clay. There are extensive forests of oak, pine, chestnut, cork, etc. The manufactures are few and unimportant, being chiefly woollen, silk,

linen and cotton stuffs, paper, glass, earthenware, gloves, tobacco, jewellery. Ship building and the fisheries are also carried on to a considerable extent. The exports are chiefly wine, fruits, oil, cork, salt. The total value of the exports (1879) was £4,920,480; imports, £8,171,040. About half the export trade, and more than one-third the import, is with Great Britain. The government is a constitutional representative monarchy. The Cortes consists of a house of peers and a house of representatives, the former having about 100 members nominated for life by the king, the latter 149 members elected by the voice of the people. The Roman Catholic is the established religion. The regular army, on the peace footing, comprises 1642 officers and 33,231 men; the navy 41 vessels with 178 guns and about 3,300 men. The revenue amounts to £7,388,762; expenditure to £8,274,753, and the national debt to £93,038,298. The area is 34,595 square miles, and the population (in 1878) 4,348,537. The principal towns are Lisbon, the capital, and Oporto, with 233,389, and 108,346 inhabitants respectively.

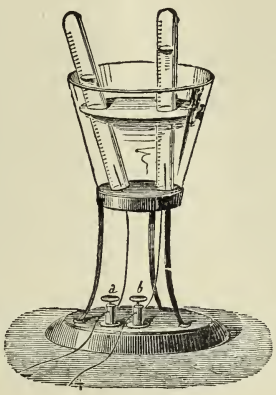
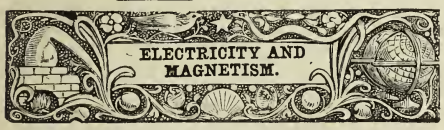


FIG. 57.



XVI.

VOLTAIC ELECTRICITY (*continued*).

WE have already seen, in our inquiries into the origin of the voltaic current, that it results from certain chemical decompositions constantly going on in the cells of a battery, and we have also seen that the attraction of the poles of the battery is sufficiently strong to tear apart the atoms of which compound bodies are composed, and so to maintain that constant condition of chemical activity upon which the existence and maintenance of the voltaic current entirely depend. We have now to turn our attention to a consideration of some important and interesting facts, which tend to show us that, not only within the generating cell itself, but also at a distance from it, the electric current may be made of service in the decomposition of various compounds into their respective elements.

At the commencement of the present century Nicholson and Carlisle simultaneously discovered that water could be decomposed by the voltaic current into its constituent elements oxygen and hydrogen, and that decomposition is now exhibited as one of the stock experiments of the physical lecture table. **Decomposition of water.**

Various forms of "voltameters" (as the instruments for decomposing water are termed) have been devised, but by far the simplest form, and one which we should strongly recommend our readers to make for themselves, is the one shown in fig. 57. **The voltameter.**

It consists essentially, as will be seen, of a glass basin, into the wooden bottom of which two small strips of platinum have been fastened, and to these pieces of copper wire, which are also in connection with the binding screws *a*, *b*, are attached, while from the latter wires proceed to the battery. Over the two strips of platinum two test-tubes are placed, and in these the gases which result from the decomposition of the water are collected.

Before proceeding to describe the action of this apparatus, it will be well to define certain terms which are employed in this department of electrical science.

First, then, the decomposition of any compound by the electric current is termed *electrolysis*, from the two Greek words *elektron*, amber, and *luo*, I loose or set free. **Explanation of technical terms.**

The liquids which undergo electrolysis are termed *electrolytes*.

The platinum or other terminals which are placed in the electrolyte are termed *electrodes*, from the Greek words *elektron*, amber, and *odos*, which signifies a way.

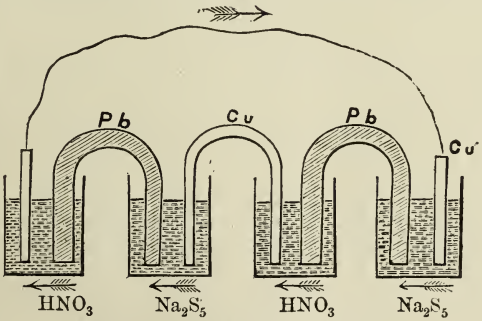


FIG. 56.—FLEMING'S BATTERY (*see p.* 450).

The electrode which constitutes the positive pole of the battery is called the *anode*, from the Greek word *anodos*, an ascent, because it is by the anode that the current enters the electrolyte.

The electrode which constitutes the negative pole of the battery is termed the *kathode*, from the Greek word *kathodos*, a return or descent, because at the kathode the current leaves the electrolyte.

The products of electrolysis which appear at the kathode are called *kations*; the elements appearing at the anode are termed *anions*.

Having made ourselves acquainted with the technology of electric decomposition at a distance from the battery, we may now proceed to consider what takes place when water is decomposed in the apparatus just described.

A battery of two or more cells is connected by means of its terminal wires with the binding screws of the voltameter, and the glass cell and test-tubes are filled with acidulated water, the acid being added to increase the conductivity of the liquid. As soon as the connection is complete, bubbles of gas appear at the electrodes, and the water in the test-tubes begins to be gradually displaced by these gases, which occupy the upper portion of the test-tubes. It will be noticed very early in the experiment that the liquid in the test-tube over the anode does not sink so rapidly as that in the other tube, —in fact, the quantity of gas in the latter throughout the experiment will be found to be about twice that in the former.

Electrolysis of water.

These two gases are the results of the decomposition of the water, which has by the force of the electric current been split up into its elementary constituents, oxygen and hydrogen, the former being evolved at the anode, the latter at the kathode. From the fact that the hydrogen is twice as great in quantity as the oxygen, we are justified in concluding that two volumes of hydrogen united with one volume of oxygen form that familiar fluid water.

Results of the decomposition.

But our readers are probably tempted to ask, "How do we know that these gases are oxygen and hydrogen?" And we reply, From the following facts :—

If we prepare oxygen by some other method than by the decomposition of water with the electric current, we find that it is an invisible, colourless gas, without taste or smell, which has the property of supporting combustion very powerfully. If, for instance, a smouldering match be plunged into a jar of it, it is re-kindled; if any body which burns in ordinary air very feebly (such, for instance, as charcoal) be ignited and plunged into oxygen it burns very rapidly and vividly; while some substances, such as iron and steel, which will not burn at all in air, may be made to burn rapidly and brilliantly in oxygen.

Properties of oxygen and hydrogen.

If the test-tube be removed from the anode of the voltameter, and a half-extinguished match be plunged in it, it will be re-kindled, and if the gas be collected in sufficient quantity the other tests for oxygen may be successfully applied. In this way the gas given off at the anode may be shown to behave precisely as oxygen does, and it can easily be seen that it is, like it, an invisible gas. We are, therefore, justified in concluding that it *is* oxygen.

In the same way we know hydrogen to be an invisible gas, which will not in the same way as oxygen support combustion, but which will itself burn with a feeble flame.

If the test-tube, placed over the kathode, be removed when full of gas and a light applied to it, it will burn with a pale flame, giving but little light.

Finally, if through a mixture of oxygen and hydrogen (in the proportion of one volume of the former to two of the latter) an electric spark be passed, the two gases will combine and form water, no residue of gas being left uncombined.

In making a voltameter we should advise our readers to get a large glass funnel and cut off the stem. Then fill the bottom up with plaster of Paris, into which, while moist, place the platinum strips, having first soldered to each a piece of stout copper-wire. The glass vessel thus formed can then be easily fastened into a wooden stand, and the wires from the electrodes soldered to two binding screws on the stand, and to these binding screws the wires from the battery can be attached when the voltameter is used.

How to make a voltameter.

Another plan is to stop the bottom of the funnel-top with a large cork, into which the electrodes may be fastened.

After filling the test-tubes care must be taken not to spill any of the contents (and thus admit air) in inverting them over the electrodes. Their mouths should be tightly closed with the thumb until brought under the water in the voltameter. Also, in removing the test-tubes for examination when filled with gas, the thumb should be made to tightly plug the mouth of each tube until the lighted match or other test is plunged into it.

Not only can water be thus decomposed by the voltaic current, but many other compound bodies can be similarly acted upon. Indeed, compounds may be readily divided into two classes—those which *are* and those which *are not* susceptible of decomposition by the electric current. With regard to gases and vapours, we find that all of these without exception refuse to conduct the current, and therefore cannot be decomposed by it, as it is an indispensable and indeed obvious condition that an electrolysis must be a conductor.

Electrolysis of other compounds.

Solids may be divided into conductors and non-conductors; but those which conduct the current undergo no chemical change, and those which do not conduct cannot of course be affected by the current.

Some liquids, such as molten metals and mercury, conduct freely without being decomposed by the current; others refuse altogether to act as conductors; while a third class both conduct the current and are decomposed by it.

Some of the earliest, and at the same time most valuable results of electrolysis, were obtained by Sir Humphrey Davy in the year 1807, by which he succeeded in showing that several substances formerly thought to be elements were in reality compounds.

Sir Humphrey Davy's discoveries.

The first substance operated upon by Davy was ordinary potash, which, by a battery of about 250 elements, he succeeded in splitting up, and showing that its base consisted of an extremely light metal, having a great affinity for oxygen, and consequently speedily tarnishing in the air, which he named potassium. This metal when placed upon water decomposes it, uniting with its oxygen, and the heat produced by this chemical action is sufficiently great to set fire

Potassium.

to the hydrogen which is liberated, thus forming a very pretty experiment.

Soda was next electrolytically examined by Davy, and from it he soon succeeded in obtaining a metal greatly resembling potassium, which he named sodium.

Sodium.

In these experiments it was found necessary to fuse the potash and soda, as in the solid state they, in accordance with what we have stated above, refused to conduct the current, and could not, therefore, be affected by it.

In the decomposition of potash and soda we have a process precisely analogous to that which we have when water is decomposed. One element (oxygen) goes to the positive electrode, and the other (potassium or sodium, as the case may be) is liberated at the negative electrode. Until the molecules of the potash or the soda are to a certain extent separated by heat, the current is powerless to effect their decomposition.

The substances separated at the positive electrode are, in accordance with our frequently-enunciated law of electrical attractions, termed *electro-negative* elements, while those liberated at the negative electrode are termed *electro-positive* elements; and it is possible to arrange the elements in such a way that any one is electro-negative to any below it, but electro-positive to any one above it. Such a list is termed an *electro-motive* series. In such a series oxygen would be placed at the top and potassium at the bottom.

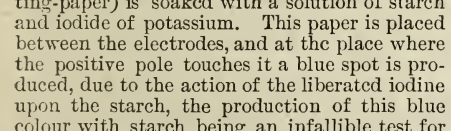
Electro-motive series.

It must be clearly understood that any element which is electro-positive in one combination may be electro-negative in another, and *vice versâ*.

A very simple electrolytic experiment, and one which may be performed with a single cell, is the decomposition of iodide of potassium. This substance consists of iodine and potassium, and in its electrolysis the iodine is set free at the positive electrode and the potassium at the negative electrode.

Electrolysis of iodide of potassium.

In performing the experiment with a single cell, a piece of bibulous paper (such as blotting-paper) is soaked with a solution of starch and iodide of potassium. This paper is placed between the electrodes, and at the place where the positive pole touches it a blue spot is produced, due to the action of the liberated iodine upon the starch, the production of this blue colour with starch being an infallible test for free iodine.



XLI.

Double Stars.

A VERY great number of double stars are now known, a number perhaps merely optically double; but, on the other hand, a great number are true double stars, or systems of bodies moving round their common centre of gravity.

The observation of these double stars forms one of the more interesting branches of telescopic work, and is one which possesses peculiar fascination for most amateur observers. It is indeed one well within their reach, for it only requires the possession of a good equatorial telescope.

Double stars afford also very good tests of the quality of a telescope. A telescope of good quality ought to be able to separate, or divide as it is called, a double star whose nearly equal components of about the sixth magnitude are not more than $4{\cdot}5'' \div$ (aperture of telescope in inches) apart: that is to say, should show the two stars as perfectly separated from each other, and visible as being rounded discs, as in fig. 97. If the star is only elongated, as in the next figure, it is not said to be separated or divided. On the other hand, if the stars are small—say of the eighth or ninth magnitude—they will be shown, as in the third figure, without diffraction rings round them; or, if the brighter star be of the third or fourth magnitude, and the smaller star of about the eighth or ninth, it will be visible something like in the fourth figure. A single moderately bright star should appear quite circular, and surrounded by delicate diffraction rings, as in *e* of fig. 98.

Division of double stars.

Appearance of double stars.

Over ten thousand double stars are now known, and many others are being discovered every year. The greater number of these are of slight importance; but some few are of exceptional interest. The following list contains a selection of these double stars. There is given first the name of the star, then its R.A. and Dec., a + showing north declination and a — south declination. Next follows the standard magnitude of the stars, then their position angle and distance; the position angle being measured from the brighter star in the way described in page 603 of vol. i. Lastly there is given the colours of the two stars.

Catalogue of stars.

η *Cassiopeiæ*.—R.A. $= 0^h\ 42^m$. Dec. $= +57°\ 11'$. Mag. 4 and $7\frac{1}{2}$. Pos. ang. 160°. Dist. 5″. White and reddish-white. A binary star.

μ *Andromeda*.—R.A. $= 0^h\ 50^m$. Dec. $= +37°\ 51'$. Mag. 4 and 13. Pos. ang. 115°. Dist. 45″. White and grey. A good test for the delicacy of the eye.

α *Ursæ Minoris*.—R.A. $= 1^h\ 15^m$. Dec. $= +88°\ 40'$. Mag. 2·5 and 9. Pos. ang. 210°. Dist. 19″. Yellow and white.

γ *Arietis*.—R.A. $= 1^h\ 47^m$. Dec. $= +18°\ 42'$. Mag. $4\frac{1}{2}$ and 5. Pos. ang. 358°. Dist. 8·8″. White.

ϵ *Triangulum*.—R.A. $= 1^h\ 56^m$. Dec. $= +32°\ 42'$. Mag. $5\frac{1}{2}$ and $12\frac{1}{2}$. Pos. ang. 110°. Dist. 5″. Yellowish-white.

α *Piscis*.—R.A. $= 1^h\ 56^m$. Dec. $= +2°\ 11'$. Mag. 5 and 6. Pos. ang. 326°. Dist. 3·1″. Bluish-white and yellowish-white. Colours thought to be variable.

γ *Andromeda*.—R.A. $= 1^h\ 57^m$. Dec. $= +41°\ 45'$. Mag. $3\frac{1}{2}$ and $5\frac{1}{2}$. Pos. ang. 62°. Dist. 10″. Deep-yellow and green. The smaller

star is in turn double, but very close. Pos. ang. 98°. Dist. 0·4″. Colours green and blue. A binary, and now closing up. Test for large apertures.

ι Triangulum.—R.A. = 2h 5m. Dec. = + 29° 44′. Mag. 5½ and 7. Pos. ang. 79°. Dist. 3·5″. Topaz yellow and bluish-green.

ν Ceti.—R.A. = 2h 30m. Dec. = + 5° 3′, Mag. 4½ and 12. Pos. ang. 85°. Dist. 6″. Yellow, blue; companion perhaps variable.

γ Ceti.—R.A. = 2h 37m. Dec. = + 2° 44′. Mag. 3 and 7. Pos. ang. 286°. Dist. 2·6″.

π Arietis.—R.A. = 2h 43m. Dec. = + 16° 58′. Mag. 5, 8½, and 11½. Pos. ang. 122° and 110°. Dist. 3·1″ and 25″. Smaller companion perhaps variable.

ε Arietis.—R.A. = 2h 52m. Dec. = + 20° 52′. Mag. 5 and 6½. Pos. ang. 204°. Dist. 1·4″. White. Probably a binary. Certainly becoming rapidly wider.

52 *Arietis.*—R.A. = 2h 58m. Dec. = + 24° 47′. Mag. 6½, 7, 12, 12. Pos. ang. 269°, 355°, and 85°. Dist. 0·8″, 5″, and 105″. White, blue, blue, and lilac. A quadruple star. The two closer form probably a binary pair.

94 *Ceti.*—R.A. = 3h 7m. Dec. = −1° 39′. Mag. 5½ and 13½. Pos. ang. 260°. Dist. 5″. White, bluish. A very delicate test; not easy even in large telescopes.

30 *Tauri.* — R.A. = 3h 42m. Dec. = +10° 46′. Mag. 6 and 10. Pos. ang. 59°. Dist. 9″. Pale emerald and purplish.

ζ Persei. — R.A. = 3h 47m. Dec. = +31° 32′. Mag. 3½, 10½, 12, 11, 10½. Pos. ang. 207°, 290°, 198°, 185°. Dist. 13″, 34″, 90″, 121″. White, small comites, blue.

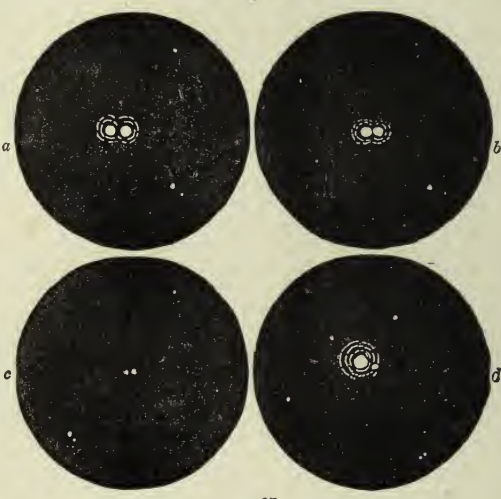


FIG. 97.

a, Double star, separated; *b*, Double star, not quite separated; *c*, Small double stars; *d*, Unequal double star, with faint companion.

o² Eridani.—R.A. = 4h 10m. Dec. = − 7° 50′. Mag. 5 and 9½. Pos. ang. 107°. Dist. 84″. Orange and blue. Companion double, 9·5 and 10·8. Pos. ang. 118°. Dist. 3·2″. Probably a binary double. The whole system is rapidly moving in the heavens.

80 *Tauri.*—R.A. = 4h 23m. Dec. = + 15° 23′. Mag. 6 and 8½. Pos. ang. 5°. Dist. 0·6″. Yellowish.

ι Leporis.—R.A. = 5h 7m. Dec. = − 12° 1′. Mag. 4½ and 11. Pos. ang. 337°. Dist. 15″. White and violet.

ρ¹ Orionis.—R.A. = 5h 7m. Dec. = + 2° 43′. Mag. 5 and 10. Pos. ang. 62°. Dist. 6·8″. Orange and pale blue.

κ Leporis.—R.A. = 5h 8m. Dec. = − 13° 5′. Mag. 5 and 9. Pos. ang. 0°·0. Dist. 3·7″. White.

β Orionis.—R.A. = 5h 9m. Dec. = − 8° 20′. Mag. 1 and 8. Pos. ang. 200°. Dist. 9·5″. Yellow and blue. Companion itself a very close double.

η Orionis.—R.A. = 5h 18m. Dec. = − 2° 3′. Mag. 4 and 5. Pos. ang. 78°. Dist. 0·9″. White. A capital test.

ψ² Orionis.—R.A. = 5h 21m. Dec. = + 2° 59′. Mag. 5½ and 11½. Pos. ang. 322°. Dist. 2·8″.

33 *Orionis.*—R.A. = 5h 25m. Dec. = + 3° 12′. Mag. 6 and 8. Pos. ang. 26°. Dist. 2″.

γ Orionis.—R.A. = 5h 29m. Dec. = + 9° 51′. Mag. 4, 6, 12. Pos. ang. 43° and 183°. Dist. 4·5″ and 29″. Yellow, blue, blue. Triple.

ζ Orionis.—R.A. = 5h 35m. Dec. = − 2° 0′. Mag. 2.8, 6½, 10. Pos. ang. 149° and 8°. Dist. 2·5″ and 56″. Yellow, blue, blue.

52 *Orionis.*—R.A. = 5h 42m. Dec. = + 6° 25′. Mag. 6 and 6½. Pos. ang. 200°. Dist. 1·8″.

4 *Monoceros.*—R.A. = 6h 3m. Dec. = − 11° 8′. Mag. 6, 11, and 12. Pos. ang. 179° and 244°. Dist. 3·4″ and 10″. Yellow, blue, blue.

μ Geminorum. — R.A. = 6h 16m. Dec. = + 22° 34′. Mag. 3, 12. Pos. ang. 76°. Dist. 73″. Yellow and blue. Fine contrast in hue.

12 *Lyncis.*—R.A. = 6h 36m. Dec. = + 59° 34′. Mag. 6, 6½, and 7½. Pos. ang. 128° and 305°. Dist. 1·4″ and 8″. White, reddish, and bluish. Fine triple.

α Geminorum. — R.A. = 7h 27m. Dec. = + 32° 9′. Mag. 3 and 3½. Pos. ang. 235°. Dist. 5·6″. White. A splendid pair, though wide.

κ Geminorum. — R.A. = 7h 37m. Dec. = + 24° 41′. Mag. 4 and 10. Pos. ang. 232°. Dist. 6″. Orange and blue. The companion has been supposed very variable.

6 *Cancri.*—R.A. = 7h 56m. Dec. = + 28° 8′. Mag. 5, 12½, 13. Pos. ang. 70° and 180°. Dist. 70″ and 65″.

ζ Cancri.—R.A. = 8h 5m. Dec. = + 18° 1′. Mag. 6, 7, and 7½. Pos. ang. 90° and 130°. Dist. 0·8″ and 5·6″. Yellowish-white. All these form part of one system.

φ² Cancri.—R.A. = 8h 20m. Dec. = + 27° 20′. Mag. 6·4 and 6·6. Pos. ang. 214°. Dist. 4·8″. White.

ε Hydræ.—R.A. = 8h 40m. Dec. = + 6° 51′. Mag. 4, 8½, and 14½. Pos. ang. 220° and 192°. Dist. 3·5″ and 20·5″. White, purple, blue. The minute companion very difficult.

σ² Cancri.—R.A. = 8h 47m. Dec. = + 31° 2′. Mag. 6 and 6½. Pos. ang. 335°. Dist. 1·4″. Yellow.

ι Ursæ Majoris.—R.A. = 8h 51m. Dec. = + 48° 31′. Mag. 3½ and 12. Pos. ang. 357°. Dist. 9·8″. Yellow and purple.

σ^2 *Ursæ Majoris.*—R.A. = 9^h 0^m. Dec. = + 67° 37′. Mag. 5½ and 10. Pos. ang. 244°. Dist. 2·5″. White and blue.

θ Hydræ.—R.A. = 9^h 8^m. Dec. = + 2° 47′. Mag. 4½ and 11. Pos. ang. 168°. Dist. 45″. Yellow.

38 *Lyncis.*—R.A. = 9^h 11^m. Dec. = + 37° 19′. Mag. 4 and 7½. Pos. ang. 242°. Dist. 2·8″. White.

γ Leonis.—R.A. = 10^h 13^m. Dec. = + 20° 27′. Mag. 2 and 3½. Pos. ang. 113°. Dist. 3·4″. Yellow.

49 *Leonis.*—R.A. = 10^h 29^m. Dec. = + 9° 16′. Mag. 6 and 9. Pos. ang. 158°. Dist. 2·5°. White and blue.

ξ Ursæ Majoris.—R.A. = 11^h 12^m. Dec. = + 32° 13′. Mag. 4 and 5. Pos. ang. 280°. Dist. 1·8″. White.

ν Ursæ Majoris.—R.A. = 11^h 12^m. Dec. = + 33° 45′. Mag. 4 and 11. Pos. ang. 147°. Dist. 7·8″. Orange and blue. Good test for moderate apertures.

ι Leonis. — R. A. = 11^h 18^m. Dec. = + 11° 12′. Mag. 4 and 7½. Pos. ang. 69°. Dist. 2·9″. Yellow and pale blue.

2 *Coma Berenicis.* — R.A. = 11^h 58^m. Dec. = + 22° 8′. Mag. 6 and 7½. Pos. ang. 240°. Dist. 3·6″. White and bluish.

γ Virginis.—R.A. = 12^h 36^m. Dec. = —0° 47′. Mag. 4 and 4. Pos. ang. 156°. Dist. 5·0″. White, yellowish-white. A beautiful binary pair, which have been widening since they closed up in 1836.

35 *Coma Berenicis.* — R.A. = 12^h 47^m. Dec. = + 21° 54′. Mag. 5, 8, 9½. Pos. ang. 63° and 127°. Dist. 1·3″ and 29″. Yellowish, purplish, and blue.

ζ Ursæ Majoris.—R.A. = 13^h 19^m. Dec. = + 55° 33′. Mag. 2½ and 4½. Pos. ang. 147°. Dist. 14·4″. White and pale green. Has been photographed by Bond.

π Bootis.—R.A. = 14^h 35^m. Dec. = + 16° 56′. Mag. 4 and 6. Pos. ang. 101°. Dist. 6″.

ζ Bootis.—R.A. = 14^h 35^m. Dec. = + 14° 15′. Mag. 3½ and 4. Pos. ang. 299°. Dist. 1·0″.

ϵ Bootis.—R.A. = 14^h 40^m. Dec. = + 27° 35′. Mag. 3 and 6½. Pos. ang. 325°. Dist. 3·1″. Orange and greenish-blue. It is easier with small apertures than with 5 to 6 inches.

η Coronæ Borealis.—R.A. = 15^h 18^m. Dec. = + 30° 43′. Mag. 5½ and 6. Pos. ang. about 120°. Dist. 0·4″. A rapidly revolving binary pair, now at about their closest.

μ Bootis.—R.A. = 15^h 20^m. Dec. = + 37° 47′. Mag. 4 and 8. Pos. ang. 172°. Dist. 109″. Yellow and greenish-white. The companion is the famous double μ^2 Bootis. Mag. 8·2 and 8·6. Pos. ang. 120°. Dist. 0·8″. Probably all members of one system.

δ Serpentis.—R.A. = 15^h 29^m. Dec. = + 10° 56′. Mag. 3 and 4½. Pos. ang. 188°. Dist. 3·6″. White and bluish-white.

α Serpentis.—R.A. = 15^h 31^m. Dec. = + 6° 48′. Mag. 2½ and 11½. Pos. ang. 354°. Dist. 59″.

β Scorpii.—R.A. = 15^h 58^m. Dec. = —19° 29′. Mag. 2, 10, 5½. Pos. ang. 87° and 25°. Dist. 0·7″ and 13″. A splendid test in good air.

σ Coronæ Borealis.—R.A. = 16^h 10^m. Dec. = + 34° 10′. Mag. 6 and 6½. Pos. ang. 206°. Dist. 3·5″. White and bluish-white. A well-known binary.

α Scorpii.—R.A. = 16^h 22^m. Dec. = + 26° 10′. Mag. 1 and 7. Pos. ang. 276°. Dist. 3·7″. Red and vivid green. A splendid pair under good atmospheric condition.

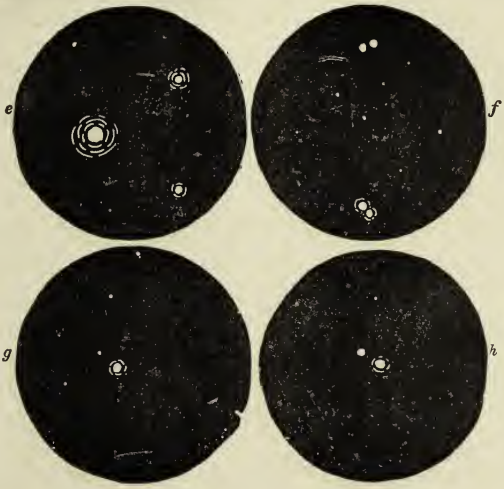


FIG. 98.

e, Single stars of different magnitudes; *f*, ϵ Lyræ; *g*, ζ Persei; *h*, ϵ Hydræ.

λ *Ophiuchi.* — R.A. = 16^h 25^m. Dec. = + 2° 15′. Mag. 4 and 6. Pos. ang. 39°. Dist. 1·7″. Yellow.

ζ Herculis.—R.A. = 16^h 37^m. Dec. = + 31° 49′. Mag. 3 and 6½. Pos. ang. 105°. Dist. 1·4″. Yellow. Binary pair. Period about 35 years.

μ Draconis. — R.A. = 17^h 3^m. Dec. = + 54° 38′. Mag. 4½ and 5. Pos. ang. 167°. Dist. 2·4″. Binary.

α Herculis.—R.A. = 17^h 9^m. Dec. = + 14° 32′. Mag. 3 and 6. Pos. ang. 118°. Dist. 4·7″. Orange and green.

ρ Herculis.—R.A. = 17^h 20^m. Dec. = + 37° 15′. Mag. 4 and 5½. Pos. ang. 308°. Dist. 3·7″. Bluish-white and fine green.

μ Herculis.—R.A. = 17^h 42^m. Dec. = + 27° 48′. Mag. 4 and 10. Pos. ang. 242°. Dist. 30′. Yellow and blue. Companion a rapidly moving binary. Mag. 10½ and 11. Pos. ang. 255°. Dist. 0·9″.

70 *Ophiuchi.*—R.A. = 17^h 59^m. Dec. = + 2° 32′. Mag. 4½ and 7. Pos. ang. 65°. Dist. 2·9′. Binary. Period of 80 years.

α Lyræ.—R.A. = 18^h 33^m. Dec. = + 38° 40′. Mag. 0·8 and 10½. Pos. ang. 150°. Dist. 46″. White and blue.

ϵ Lyræ.—R.A. = 18^h 40^m. Dec. = + 39° 33′. A double double, separated by about 200″. Mag. 5 and 6½. Pos. ang. 20°. Dist. 3·0″. Mag. 5 and 5½. Pos. ang. 148°. Dist. 2·5″. Between the two are a 9 mag. star and two 11½ mag. stars. Some 12 and 13 mag. stars lie near there.

17 *Lyræ.*—R.A. = 19^h 3^m. Dec. = + 32° 19′. Mag. 6 and 10½. Pos. ang. 322°. Dist. 3·6″. Yellow and blue.

β *Cygni.*—R.A. = 19h 26m. Dec. = +27° 42′. Mag. 3 and 6. Pos. ang. 56°. Dist. 3·4″. Golden-yellow and blue.

δ *Cygni.*—R.A. = 19h 41m. Dec. = +44° 50′. Mag. 3 and 8. Pos. ang. 320°. Dist. 1·5″. Yellow and bluish-green. Fine test. Is a binary with period of some 200 years.

π *Aquila.*—R.A. = 19h 43m. Dec. = +11° 31′. Mag. 6 and 7. Pos. ang. 121°. Dist. 1·5″. White.

o^2 *Cygni.*—R.A. = 20h 10m. Dec. = +46° 23′. Mag. 4 and 13. Pos. ang. 320°. Dist. 37″. White and blue.

α^2 *Capricorni.*—R.A. = 20h 11m. Dec. = +12° 55′. Mag. 3 and 13½. Dist. 5″. Companion in turn double, 13½ and 14. Pos. ang. 250°. Dist. 1·8″. A fine test for large telescopes.

1 *Delphini.*—R.A. = 20h 24m. Dec. = +10° 30′. Mag. 6, 11½, and 14. Pos. ang. 342° and 359°. Dist. 0·9″ and 15″. A most difficult object.

ϵ *Equulei.*—R.A. = 20h 53m. Dec. = +3° 50′. Mag. 5½, 6, and 7½. Pos. ang. 288° and 78°. Dist. 0·8″ and 11″. Yellow, yellow, and blue. The close pair a fine binary.

γ *Equulei.*—R.A. = 21h 5m. Dec. = +9° 39′. Mag. 5, 11, and 13½. Pos. ang. 277° and 10°. Dist. 2·1″ and 42″. Yellow, blue, and blue.

τ *Cygni.*—R.A. = 21h 10m. Dec. = +37° 22′. Mag. 5 and 8. Pos. ang. 150°. Dist. 1″. A rapid binary.

β *Aquarii.*—R.A. = 21h 25m. Dec. = −6° 6′. Mag. 3 and 13. Pos. ang. 320°. Dist. 25″. Difficult.

ζ *Aquarii.*—R.A. = 22h 23m. Dec. = −0° 38′. Mag. 4 and 4½. Pos. ang. 334°. Dist. 3·7″. Yellow.

π *Cephei.*—R.A. = 23h 4m. Dec. = +74° 44′. Mag. 5 and 9. Pos. ang. 24°. Dist. 1·3″. Yellow and purple.

o *Cephei.*—R.A. = 23h 14m. Dec. = +67° 27′. Mag. 6 and 9. Pos. ang. 194°. Dist. 2·5″. Orange and deep blue.

σ *Cassiopeia.*—R.A. = 23h 53m. Dec. = +55° 5′. Mag. 6 and 8. Pos. ang. 324°. Dist. 7″. White and green.

The above form a catalogue of some eighty-six double stars, which are either of especial interest from their colours or characters, or are else of use for testing the capabilities of both telescope and observer. Some of the binary stars move so rapidly in both position angle and distance, that in the space of a few years the values given in the catalogue for the Epoch 1882 will be found to be no longer accurate; but in the greater number the stars move so slowly that the above value will be found true for many years to come.

It has already been observed that the binary stars are known to be systems of double or multiple suns, moving round their common centre of gravity, and according to the known laws of gravitation. The orbits of many of these stars have been regularly computed, and found to agree well with the actual motion of the system, thus conclusively proving that the law of gravitation holds good all over the universe. The principal of these binaries are the following:—

Binary stars.

	Period years.	Epoch of Periastron.	Semi-axis Major.
ζ Herculis	34·6	1864·9	= 1·36″
η Coronæ	40·2	1849·9	= ·99″
ξ Ursæ	60·6	1875·5	= 2·54″
ζ Cancri	62·4	1869·3	= ·90
70 Ophiuchi	92·8	1807·9	= 4·88
γ Virginis	175·0	1836·5	= 3·39
γ Cassiopeæ	222·4	1909·2	= 9·83
λ Ophiuchi	234·0	1803·9	= 1·19
μ^2 Bootis	280·3	1863·5	= 1·47
γ Leonis	402·6	1741·1	= 2·00
δ Cygni	415·1	1904·1	= 2·31

All the above stars are contained in the list which has been given.

XLII.

Various Orders (*continued*).

While speaking of flowers of very simple structure, we may appropriately pass on to the spurge family, one of the very large and supremely important ones. In the Euphorbiaceæ, as in the Leguminosæ, we find great trees, shrubs innumerable, a vast crowd of inconspicuous herbaceous plants, and at the same time illustrations of almost every thing that is quaint, not to say grotesque, in configuration. Yet no order is described, as to essential characters, in fewer words. That there shall be exceptions to those characters, is of course to be expected, but one with another it is enough to say of the Euphorbiaceæ that they are diclinous exogens, with a tricoccous fruit, the cells of which are one-seeded. There is no agreement in respect of foliage, leaves of every description occurring: every kind of inflorescence is also met with, and the colour of the flowers is varied almost as wonderfully. As a rule, the perianth, when present, is trifling, and greenish, or of some pale tint that attracts no attention. Frequently, as in the Amarantaceæ, the bracts are brilliant; and not only so, but in many cases of great size, so that the effect produced is quite commensurate with that of the gayest genuine flowers. Universally diffused, and having many representatives wild in our own island, the Euphorbiaceæ are still most plentiful in warm countries. Their properties also are various, with great predominance of the venomous or actively medicinal. Indeed, it is never safe to trust an unknown euphorbiaceous plant. The familiar British members of this great order consist chiefly of genuine spurges, most of them green and weedy herbaceous plants, though in two or three cases of striking appearance. The caper-spurge of old-fashioned gardens is remarkable in its foliage; so is the great sea-spurge of the maritime sand-hills. The most abundant indigenous representative is nevertheless the common dog's mercury of the hedgebanks, a very interesting plant, alike in regard to its flowers and to the blue dye

The Euphorbiaceæ.

which it affords. The stamens and pistils are produced upon different individuals, the latter very curiously exceptional in having only two ovaries instead of three. The common box-tree, also accounted indigenous, again affords a remarkable instance of departure from the typical character, the carpels containing two seeds instead of only one. In gardens many other true euphorbias occur, and in green-houses and hothouses the number is augmented by various tropical species, both of the same genus and its allies, these last including the gorgeous Poinsettia,—the plant with the great scarlet coronet exhibited so abundantly in the markets in winter-time. Under glass are also cultivated many species that are valuable for the beauty of their foliage, these consisting chiefly of the splendid so-called "crotons," properly codiæums, in the leaves of which all shades of green, golden, amber, and crimson intermingle. Various species of Phyllanthus are also esteemed for their decorative utility, not to mention the tropical species, which, being sources of economic substances gathered from them in their native countries, are in England kept as curiosities. Such are the candle-tree, the croton-oil plant, the cassava-plant, the Hevea or Siphonia elastica, which gives indiarubber, and the castor-oil plant. The last-named flourishes admirably in the open garden, if treated as an annual of tender nature—reared, that is to say, upon a hotbed, and planted out when old and strong enough. Being of sub-tropical origin, of course it succumbs to the cold of November. A handsomer plant it would be difficult to find, the vast leaves being quite enough to reward the cultivator. The oil is expressed from the seeds. The cassava-plant above named is that to which we are indebted for tapioca, prepared from the great tubers, and almost the only instance of a euphorbiaceous plant being a food-giving one.

The Proteaceæ.

Evergreen shrubs and small trees of the most wonderful diversity of complexion, and seldom failing in respect of beauty, constitute the order which bears the very happy name of Proteaceæ. Proteus, it will be remembered, was the fabulous being in the old Greek mythology which could change itself into any form it pleased—beast, bird, or fish. To imagine a greater diversity than is found either in the leaves or the inflorescence of the Proteaceæ is quite impossible, and yet the individual flowers closely resemble one another all through the order. They consist of a single perianth, usually tetramerous, with four stamens and a superior and one-celled ovary. In some of the genera—Protea very emphatically—they are collected into magnificent cones, the bracts or scales of which are brilliantly coloured. To describe only a tenth part of these wonderful shrubs would require many pages. They must be learned, by personal inspection, in good greenhouses, which are never deficient, when properly furnished, in Banksias, Grevilleas, Hakeas, Lomatias, Dryandras, and their multiform kindred. The greater portion of this extraordinary order belongs to the Cape of Good Hope and Australia. Hence, except in a few instances, and in favoured localities, they cannot stand the winter out of doors. Some of the species yield a prodigious abundance of honey, but none can be called economic, and not one of them, on the other hand, is in the slightest degree hurtful.

The Cucurbitaceæ.

In the presence of the valuable and always interesting plants of the cucurbit order we find ourselves at home again—these including the cucumber, the melon, the gourd, the pumpkin, and the vegetable-marrow. How engaging, too, the contrast after contemplating the Proteads! Here we have juicy-stemmed ramblers and climbers, that by means of powerful tendrils find their way into trees and bushes, and, excepting in the case of the Elaterium, would never lie prostrate upon the soil if they could help it. For when in gardens they are on the ground, it is because they are unprovided with opportunities of ascending; they have their tendrils ready, but there is nothing to take hold of in order to mount aloft. The true habit of life of a cucurbitaceous plant is exactly illustrated in our beautiful wild English bryony—whose large cucumber-like foliage often mantles the hedges. The flowers of these plants are unisexual, and sometimes dicœcious. They usually consist of both calyx and corolla; they are pentamerous, regular, and very generally yellow or greenish. In dimensions they vary from those of the star of the bryony up to the great golden chalice of the pumpkin. The fruits are illustrated in the names already cited, but in many cases they are no larger than peas. The very largest fruits known to botanists are found at the other extreme, among the gourds, these being often gigantic. The properties of the esculent fruits need no description. Besides these, however, there are illustrations of fruits of purely medicinal value, including the celebrated colocynth, one of the two bitterest of all known vegetable productions. The native countries are chiefly oriental. It was from south-western Asia that nearly all now in general cultivation were first received. Cucumbers and melons were greatly in favour with the ancient Egyptians and the ancient Hebrews, as shown by the references to them in the Old Testament. These were the watermelon and the fruit of the Cucumis Chatë.

Having given a fair idea of the nature of the natural orders or families of Exogens, there is no occasion to deal with the others after the same manner as the preceding. A complete account of the whole of them would demand indeed an entire volume. For the sake of students who may care to pursue the subject to its furthest stage, it may be useful to recommend that attention should first be given to the following:—

Passifloraceæ.—A beautiful order of chiefly tropical climbing plants, nearly allied to the Cucurbits, and well represented in the common Passion-flower of English gardens, renowned for the beauty of the flowers, but of no particular economic value.

Violaceæ. — The order named after the

common violet, including both herbaceous and undershrubby plants, the latter exclusively South American.

Epacridaceæ.—A very beautiful family of Australian shrubs, in many particulars resembling the heaths, and greatly esteemed for greenhouse ornament.

Vitaceæ.—The Grape-vine family, represented in the common grape-vine, also in the Virginian creeper. Nearly all are climbers, and all belong to extra-European countries.

Anacardiaceæ.—Remarkable and often handsome tropical and sub-tropical, or occasionally temperate-latitude, trees and shrubs. Well represented in the common sumachs of English gardens, which are species of *Rhus*. In several cases these plants are venomous.

FIG. 208.—BANANA CASTOR-OIL PLANT.

Clusiaceæ.—Another beautiful family of ligneous and arborescent plants, all tropical, and including the trees which yield gamboge. Very few occur in cultivation, and those only in first-class hothouses.

Anonaceæ.—Similar descriptive terms apply to these, all being extra-European. Celebrated as including the trees which in the West Indies produce "custard apples."

Byttneriaceæ.—Again of the same general character, being wholly exotic, and in England little known. Here we find the invaluable tree which yields the seeds manufactured into "cocoa," the most nutritive of all vegetable beverages.

Cactaceæ.—The Cactuses are well known through the oddity of their forms, which often seem to be castings in bronze, and the splendour very generally of their flowers. All are American, and all are innocent. The celebrated "cochineal insect" lives and feeds upon one of them; and this gives the fruit called the "prickly pear."

FIG. 209.—BANKSIA (*fruit*).

Onagraceæ.—These are mostly herbaceous plants with pretty flowers, including about a dozen British species, conspicuous among which are the willow-herbs. There are also a few ligneous species, represented in the lovely and familiar fuchsia.

Campanulaceæ.—The Campanulas are also freely represented among our wild flowers. Very many foreign species are likewise familiar, with numbers of beautiful herbaceous plants of other genera. Here we find the genuine "bluebell of Scotland"—Campanula rotundifolia.

Lobeliaceæ.—The plants of this order are very nearly allied to the preceding. The flowers are of rare beauty, and in a few cases the species are medicinal.

Verbenaceæ.—The Verbena family, again freely represented in English gardens, and having also a solitary example among our wild flowers—the "Vervain" of the old poets.

Saxifragaceæ.—The Saxifrages and their innumerable allies are inhabitants chiefly of cold and temperate countries, loving mountain-sides. All are herbaceous, and all are innocuous as well as pretty. The common garden flower called "London pride" gives an excellent idea of their general character and complexion.

Urticaceæ.—The nettles, plants that speak for themselves, though there are very many species which do not sting.

Cannabinaceæ.—A little order constituted simply of the common hop plant and the common hemp plant.

Moraceæ.—These are nearly all trees, chiefly Asiatic, and including among their number the fig-tree and the mulberry.

Juglandaceæ.—The Walnut-tree family, a very small one, extra-European, and rendered noteworthy by the renowned fruit of the Juglans regia, a native of Persia.

Corylaceæ.—The Corylaceæ are so named from corylus, the genus which includes the filbert and the hazel-nut. Here too are located the oaks, in their three hundred kinds, the beeches, the hornbeam, and the inestimable sweet or Spanish chestnut.

Betulaceæ.—Ligneous plants again, and mostly arborescent, the members consisting of the birch-trees in their various kinds, and the alders, also of many sorts.

Salicaceæ.—Under this name are associated the poplar-trees in their several sorts, and the multitudinous willows, sallows, and osiers.

Platanaceæ.—An order consisting of little besides the two magnificent plane-trees—the Oriental and the American.

Principal Endogenous Orders.

The families of the Endogens fall under three general heads—the lily-like, the grass-like, and the spathaceous; the two first-named very easily identified, the third rather a medley. The lily-like orders are chiefly the true lilies, or Liliaceæ; the snowdrop family, or

Amaryllidaceæ; the crocus family, or Iridaceæ; and the orchis family, or Orchidaceæ. There are seven or eight besides; but the great mass of the lily-like plants pertain to one or other of these four,—although many of the most interesting and valuable plants in nature are referable to the pine-apple family, Bromeliaceæ; the colchicum family, Melanthaceæ; the banana family, Musaceæ; and the rush family, Juncaceæ. The grass-like orders cover little besides the true grasses, Gramina, and the sedge-like plants, Cyperaceæ. The spathaceous ones are represented emphatically by the palm-trees, and in almost equal degree by the Araceæ.

Intermediate Families.

Lastly, there are the profoundly interesting groups which are neither strictly exogens nor endogens. The chief of these are the magnificent order constituted of the pine-trees, the fir-trees, the cedars, the cypresses, and their allies, collectively called the Coniferæ; the Cycadaceæ, a wonderful order, exclusively of the southern hemisphere; the sarsaparilla family, or Smilaceæ; and the yam family, Dioscoreaceæ. There is also a very singular little group named the Taxaceæ, from containing the common yew-tree, Taxus baccata.

The yew is the only European tree possessed of poisonous properties,—and these, singular to say, are not present in every portion. The leaves are fatal to horses and other animals. The seeds are fatal to mankind, but the scarlet and juicy cup in which the seed is embedded may be eaten with safety. It is viscid, sweetish, and is perfectly innocuous. We know of only one similar case of a poisonous leaf and seed accompanied by a pulpy fruit which holds nothing hurtful in its juice—and that is the common cherry-laurel, *Cerasus Lauro-cerasus*, a native of Asia Minor, whence it was introduced to this country in the reign of Elizabeth.

FIG. 210.—MELONS.
Cucumis: (a) C. citrullus; (b) C. melo.

The orders of the flowerless plants or Cryptogamia were described in Chapters XXIV. to XXVII.

Here we shall cease our instructions on a subject which has a peculiar fascination for all lovers of nature. We might go on to much greater length, but we have perhaps said enough to put the student on the right road for a thorough acquaintance with the marvels of the vegetable kingdom.

END OF "BOTANY."

XLI.

Analysis of Sentences (*concluded*).

§ 246. The Compound Sentence.
§ 247. Examples of the same.
§ 248. The Complex Sentence: (*a*) noun-sentence, (*b*) adjective-sentence, (*c*) adverbial-sentence.
§ 249. Phrases: noun-, adjective-, and adverbial.
§ 250. Example of complex sentence.
§ 251. Complex sentences for practice.

§ 246. **The Compound Sentence.**—In previous sections the compound sentence has been described, and some instances given (see §§ 99, 223). The Co-ordinative Conjunctions, which join clauses of independent sense, are given in § 221. The conjunction *and*, which joins co-ordinate attributes referring to the same subject or object (see above, § 245), can also join several co-ordinate subjects or objects for one finite verb; these are called *contracted* sentences (see § 230, *d*), and may be either simple, as in the instance above, a clause of a complex sentence, as in the last example in § 223, or compound, as—

"My hat and wig will soon be here."—Cowper.

"Childhood and youth, friendship and love's first glow,
Have fled like sweet dreams."
Keats.

§ 247. *Examples of Compound Sentence.*—In parsing both Compound and Complex sentences, first find the separate clauses and their connectives; each clause may be then analysed in detail like a simple sentence.

1. "They crossed the moat, and Christabel
Took the key that fitted well."
Coleridge.

1st *Co-ordinate*—They crossed the moat (and)
2nd *Co-ordinate*—Christabel took the key [that fitted well].

Here the whole sentence consists of three clauses—two co-ordinate, and one dependent on the object of the second clause, "that fitted well" being an adjectival sentence qualifying "key" (see after, § 248, *b*). We may here look upon "key that fitted well" as the enlarged object of the second clause of a compound sentence. This illustrates how different kinds of sentences run into one another.

Kind of Clause.	Subject.	Predicate.	Object.	Enlargement.
1st co-ordinate	They	crossed	moat	the
2nd co-ordinate	(And) Christabel	took	key	(1) the (2) that fitted well [adj. sentence]

2. "The day is cold and dark and dreary,
It rains, and the wind is never weary."
TENNYSON.

Kind of Clause.	Subject.	Predicate.	Extension.
1st co-ordinate	The day	is cold and dark and dreary	
2nd co-ordinate	It	rains	
3rd co-ordinate	(and) the wind	is weary	never

3. "Above the prostrate pilgrim band
The mitred abbot stretched his hand,
And blessed them as they kneeled;
With holy cross he signed them all."
SCOTT.

Kind of Clause.	Subject.	Enlargement.	Predicate.	Extension.	Object.	Enlargement.
1st co-ordinate	Abbot	The, mitred	stretched	Above the prostrate pilgrim band [adverbial phrase]	hand	his
2nd co-ordinate	(and) [subj. understood]		blessed	as they kneeled [adverbial sentence]	them	
3rd co-ordinate	he		signed	with holy cross	them	all

§ 248. **The Complex Sentence.**—We have seen that the Complex sentence is composed of *principal* and *subordinate* clauses. The subordinate clause does duty to the principal as *noun, adjective,* or *adverb;* it is therefore either a Noun-sentence, an Adjective-sentence, or an Adverbial sentence. In speaking of the Simple sentence (§ 244, *b*), we saw the Noun-sentence in the fifth enlargement of the Subject or Object; the Adverbial sentence is naturally seen in the extension of the Predicate. The Adjective-sentence is an expansion of the attribute, and *qualifies* a noun, but is not used in its place.

(*a*) *The Noun-sentence.*—This can take the place of Subject and of Object. Examples:—

Subject—*That we are reduced to poverty* is certain.

Object—I do not know *what you mean.*
I fear *that he may die.*
He was told *that she was dead.*

(1) Indirect questions and (2) quotations are noun-sentences, and are generally objects of the principal sentence.

1. Can you say *what time it is?*
Please advise me *where to go.*
2. "'She was eight years old,' she said."
WORDSWORTH.
"Red Roland Forster loudly cried,
'A deep carouse to yon fair bride.'"
SCOTT.

(*b*) *The Adjective-sentence.*—This takes the place of Attribute, and can be attached to a noun wherever one can be employed; it is joined to the principal sentence by a relative pronoun or adverb.

The seed, *which is sown,* is good (qualifies "seed").

He *who steals my purse* steals trash (qualifies "he").

The village *where I was born* lies in a valley (qualifies "village").

Be careful not to confound the noun-sentence with the adjective-sentence: the former takes the *place* of the noun, as Dogs eat *that which is bad;* the latter is *added* to the noun, as Dogs eat *meat that is bad.*

(*c*) *The Adverbial sentence.*—This takes the place of Adverb, and, like it, can modify verb, noun, or adverb; it is joined to the principal sentence by a subordinate conjunction (see before, § 222). Like other extensions of the predicate (§ 244 *c*), adverbial sentences can be sorted out according to the meanings of time, place, manner, and cause.

Time. I came away *before you did.*
They saw Vesuvius *while it was in eruption.*
Place. She will go *wherever you wish.*
Manner. Is she good *as she is fair?*
The more you learn the wiser you will be.
Cause. I came *because your horse would come.*
Take some pudding *if you please.*

§ 249. *Phrases.*—We have bestowed much attention upon sentences, but the student may note that the phrase, or group of words *without* a finite verb, occurs in the same kind of positions—namely, as noun, adjective, and adverb—and plays an important part in clothing the sentence. Examples of the three have been given under Enlargement of Subject and Object and Extension of Predicate; further examples are:—

Noun-phrase. *A bird in the hand* is worth two in the bush.
Adjective-phrase. A man *of wisdom, truth, and goodness.*
One of my friends is a lady.

Adverbial phrase. We will come to-morrow, *all being well.*
He wrote a letter *to order the funeral.*

§ 250. *Examples of Complex Sentence:—*

1. "If you desire to enjoy life, avoid unpunctual people."—WALKER.

Principal sentence. Avoid unpunctual people (if)
Subordinate sentence (adverbial). You desire to enjoy life.

Kind of Clause.	Subject.	Predicate.	Object.	Enlargement.
Subordinate, adverbial to "avoid"	(If) You	desire	to enjoy life	
Principal	[Subject suppressed in imperative mood]	avoid	people	unpunctual

2. "As I am true to thee and thine,
Do thou be true to me and mine."
SCOTT.

Kind of Clause.	Subject.	Predicate.	Object.
Subordinate, adverbial to "be true"	(As) I	am true	to thee and thine [indirect]
Principal	thou	do be true	to me and mine

3. "The little Perdita grew up a lovely maiden; and though she had no better education than that of a shepherd's daughter, yet so did the natural graces she inherited from her royal mother shine forth in her untutored mind, that no one from her behaviour would have known she had not been brought up in her father's court."—LAMB, *Tales from Shakespeare.*

This consists of six sentences or clauses.

A. The little Perdita grew up a lovely maiden } co-ordinate to C.
B. and though she had no better education than that of a shepherd's daughter } subordinate, adverbial to C.
C. yet so did the natural graces . . shine forth in her untutored mind } *Principal* sentence
D. [which] she inherited from her royal mother } adjective-sent. to "graces."
E 1. that no one from her behaviour would have known } adverbial sent. of two clauses to "shine forth" in C.
E 2. [that] she had not been brought up in her father's court. } noun-sent., object to "would have known" in E 2.

The following is the detailed analysis of these clauses; it can, of course, be put into the tabular form, but is thus given as an example of another method.

A.

The little — Attributes of subject
Perdita — Subject
grew up — Predicate
a lovely maiden — Attributive phrase in apposition to "Perdita"

B.

and though — connectives
she — Subject
had — Predicate
education — Object
no better than that of a shepherd's daughter — Adjective-phrase attrib. to "education"

C.

yet — connective
so — extension of predicate
did shine forth — Predicate
the natural graces — Subject
in her untutored mind — Object, indirect

D.

[which] — relative omitted
she — Subject
inherited — Predicate
from her royal mother — Object, indirect

E 1.

that — connective
no one — Subject
from her behaviour — Adverbial phrase, extension of pred.
would have known — Predicate

E 2.

[that] — relative omitted
she — Subject
had been brought up — Predicate
not, in her father's court — Extensions of predicate

§ 251. Complex sentences for practice in analysis.

"Antigonus never returned to Sicily to tell Leontes where he had left his daughter, for, as he was going back to the ship, a bear came out of the woods and tore him to pieces."—LAMB.

"At Edmonton his loving wife
From the balcony spied
Her loving husband, wondering much
To see how he did ride."—COWPER.

"In ancient times, as story tells,
The saints would often leave their cells,
And stroll about, but hide their quality
To try good people's hospitality."—POPE.

"Man marks not Thee, marks not the mighty hand
That, ever busy, wheels the silent spheres,
Works in the secret deep, shoots, steaming, thence
The fair profusion that o'erspreads the spring." THOMSON.

And now our study of this curious thing called speech must come to an end. If in the sketch of the early history of English some interest has been aroused in the searching out of true facts; if in the examination of the various strings of the noble instrument now our heritage some desire has been awakened that its tones, enriched by the touch of a Chaucer, a Shakespeare, or a Milton, and endeared by hallowed writings, shall not be impoverished or degraded through ignorance or base use in the present, the study will not have been in vain; for where interest and desire lie, endeavour will follow. And so, wishing success to every true and high endeavour, brother student, Farewell!

END OF "ENGLISH GRAMMAR."

XLII.

THE COMMONWEALTH (*concluded*).

THE government of the Protector was characterised by equal energy, sagacity, and prudence.

Greatness of England under Cromwell.

Since the close of Elizabeth's reign England had greatly declined in continental influence; for James's kingcraft had proved a failure, and Charles had been too deeply occupied with the internal troubles of the realm to give much attention to foreign affairs.

Cromwell, having restored internal order to the realm, found time to look after England's interests abroad; and raised the country to a degree of power and consideration it had never possessed since the day when the Armada fled baffled from its shores. Blake gained great victories at sea,—at one time chastising the half-savage rulers of the Barbary States for countenancing piracy, and compelling them to set free the British subjects kept in slavery, and sweeping the pirates themselves from the Mediterranean; at another capturing the rich Mexican treasure-ships of the Spaniards by means of his brave Captain Stayner, off Cadiz itself; and again off Vera Cruz, capturing or destroying almost the whole fleet, in spite of the guns of the forts, after a hard fight of twelve hours; and at last returning home laden with glory, and just reaching his native shore to receive an emphatic message of thanks and greeting from Protector and parliament, and to die. The capture of Jamaica by the fleet under Penn and Venables must also be recorded among the naval triumphs of this remarkable time.

Triumphs over Spain.

In his relations with foreign powers, Cromwell nobly upheld the interests of the country he governed. Any disregard of the rights of Englishmen was met by prompt measures of reprisal and punishment. When some English fishermen suffered oppression and loss at the hands of the French, he promptly gave orders to have certain French merchantmen seized and brought into English ports, there to be detained as tangible security until restitution was made. He concluded an alliance with France, for common action in the war against Spain, partook of the triumph gained over the Spanish arms, and obtained for England a very substantial pledge of victory in the shape of the town of Dunkirk, taken from Spain by the joint exertions of the allies; insisting also that King Charles and his somewhat mixed court should be compelled to quit the country. Hearing, through his secretary (Milton), of the oppression suffered by the Protestant Waldenses of Piedmont at the hands of the Duke of Savoy, he promptly declared himself the champion of those sufferers for conscience' sake, sent a fleet into the harbour of Genoa, and compelled the signature of a treaty undertaking that the persecution should cease.

English rights upheld.

Dunkirk acquired.

How little he cared for precedent was seen in the proceedings against Don Pantaleon Saa, the brother of the Portuguese ambassador, who, after having in a cowardly manner murdered an English merchant by whom he considered himself aggrieved, took refuge in the house of the Embassy, a place exempted by custom from the ordinary action of law. Cromwell promptly caused him to be arrested and conveyed to prison; to be tried, condemned, and executed; for the stern Protector deemed no place a haven of refuge for him who had slain an Englishman.

The affair of Don Pantaleon Saa.

In the last years of his life his cares and anxieties were increased by frequent plots for his assassination. One of the principal of these was the scheme of one Miles Sindercombe, in January 1657, to kill him on his way to the palace of Hampton Court. Sindercombe was arrested; and being afterwards found dead in his bed, was supposed to have taken poison. The distribution of pamphlets inciting to insurrection against his authority, and in some cases, as in the celebrated treatise "Killing No Murder," to direct assassination, harassed and annoyed him. Two royalist partisans, Colonel Titus and Colonel Sexby, have each been credited with the authorship of "Killing No Murder." As in the case of Napoleon a century and a half later, these attempts had the effect of increasing the zeal of the intended victim's partisans and followers. A direct offer was

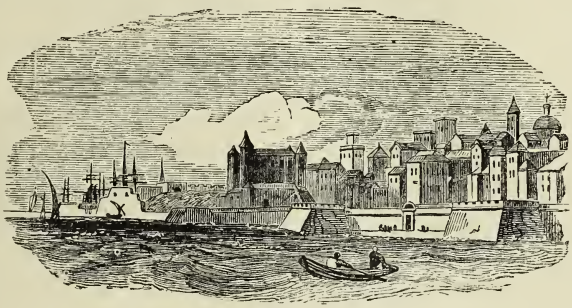
Plots and intrigues.

Sindercombe's conspiracy.

made that Cromwell should assume the regal power, in the shape of the "humble petition and advice" of parliament, proposing that the Lord Protector should govern with a higher title, and also providing for the revival of the House of Lords. Cromwell, remembering perhaps the speaker's former advice that the remedy would be worse than the disease, declined the title of king, but accepted a second humble petition, whereby he was empowered to name his successor.

Proposal to make Cromwell king.

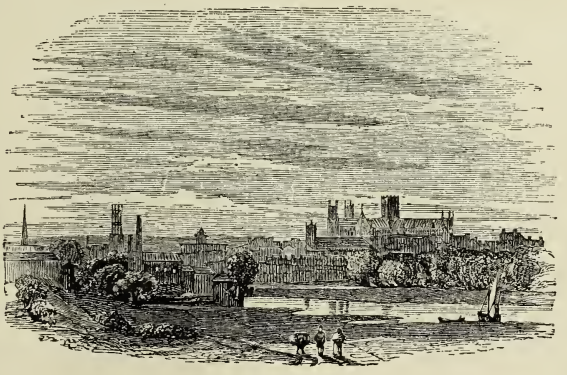
The attempt of the Marquis of Ormond to raise an insurrection in England in favour of the exiled Charles was the first great event of 1658. The design failed, and cost Dr. Hewitt and Sir Henry Slingsby, the chief agents, their lives; but Ormond succeeded in escaping to the Continent.



CADIZ.

The cares and anxieties of his position, added to the knowledge that his life was in constant danger, and perhaps to remorse for some things he had done, undermined the strength of the great Protector. Gout and ague tormented him; and the death of his favourite daughter, Lady Claypole, is considered to have hastened his own. He died in 1658, on the 3rd of September, his "great day," the anniversary of his victories of Dunbar and Worcester; passing away in the midst of a great storm, that shook the palace of Whitehall, where he lay. "I would be willing to live, to be further serviceable to God and His people," he said, shortly before he died, "but my work is done. Yet God will be with His people." He was in his sixtieth year.

Death of Cromwell.



YORK.

Oliver's eldest son, Richard, "that foolish Ishboshesh," as Macaulay appropriately calls him, succeeded to the Protectorate; but he was entirely unable to repress the strife of the factions, which broke out anew so soon as the restraining hand was cold that had maintained stern rule and order. The army again asserted its claim to supremacy. A new parliament, summoned by Richard, at the beginning of 1659, to counteract the influence of the military chiefs, was itself put down by the Council of Officers, and was dissolved under compulsion by Richard in April of the same year. Once more, by the influence of the army, the Long Parliament, a shadowy relic of its former self, was assembled, with Lenthall in the speaker's chair. A new rising of the royalists was organised under Sir George Booth and Sir Thomas Middleton, but was defeated by Lambert after taking possession of Chester; the exiled court, meanwhile, with Charles, anxiously watching the progress of affairs, in the confident expectation of a turn of affairs in favour of a monarchy. Richard Cromwell, finding his position untenable, was glad to have his debts paid, and to retire to the Continent, his brother Henry at the same time giving up his authority in Ireland.

Richard Cromwell Protector.

Conflict of factions.

The army itself was now split up into factions. General Monk, who had been commanding in Scotland, was holding aloof from the other leaders; and when Lambert, with Fleetwood, the great Protector's son-in-law, expelled the parliament and appointed a military committee of safety, Monk marched into England, with the avowed purpose of restoring the parliament; being joined by Fairfax at York, he came to London, entering the capital on 3rd Feb. 1660. Soon after he was appointed captain-general; and the release, by his orders, of Sir George Booth and other royalist prisoners indicated the turn affairs were taking.

For the feeling of the nation, now able to make its voice heard amid the jarring din, was in favour of a restoration of the monarchy; and Lambert's force was gradually dwindling away. He himself was taken prisoner by Monk, who was at this time already negotiating with Charles, and was shut up in the Tower. He escaped, and vainly endeavoured to regain his ascendency. After suffering a defeat at Daventry, he was again captured.

Lambert made prisoner.

The Long Parliament had meanwhile finally dissolved itself, and had been succeeded by the Convention Parliament; to which assembly, consisting of an upper and a lower house, letters from the king were read, full of gracious words and fair promises.

The time had come, in fact, when the setting up of the monarchy under the legitimate ruler was the wish of the great majority of the people of England. Accordingly, it became comparatively easy to adjust the conditions under which the exiled King Charles should be received among his people and restored to his throne. On the 16th of March, 1660, the Long Parliament, that during an existence of nearly twenty years had experienced every variety of fortune, came to an end, being followed by the Convention Parliament, consisting chiefly of royalists; and with the commencement of this parliament, which assembled on the 25th of April, the restoration became a certainty. The House of Lords was at the same time restored, though only ten peers took their seats, as representing the Upper House, on the opening day.

End of the Long Parliament.

Monk continued to maintain the character of a general of the Republic long after he had entered into negotiations with Charles, who with the exiled court had moved from Brussels to Breda; and it was not until he felt sure of his position, and of the general tone of public opinion, that he openly declared for the king. By the declaration of Breda, Charles pledged himself to grant liberty of conscience to all his subjects, and an amnesty for all political offences arising out of the late rebellion. From this Act of Oblivion, however, certain persons were to be excepted, to be thereafter designated by Act of Parliament. This clause was especially aimed at the members of that high court of justice who had sat in judgment on Charles I.

Negotiation of Monk with Charles II.

A supply of money was despatched to Holland for the immediate necessities of the king, who now, at once, proceeded to take possession of the throne almost unexpectedly offered to him. On the 25th of May he landed at Dover, and thence, amid rejoicings that rose to a universal burst of jubilation, he made his way towards London. Not even Henry V., returning from famous Agincourt crowned with laurels, received such a welcome as was accorded to Charles II., when, on the 29th of May, the thirtieth anniversary of his birthday, he entered the capital. Even the old soldiers of Oliver, drawn up on Blackheath to receive him, had acquiesced, not altogether unwillingly, in the change from republic to monarchy. As for the mass of the people, they were utterly weary of the stern repression the "reign of the saints" had brought with it; and regarded the new state of things as the commencement of a golden age, now that the aspirations of the old cavalier song were fulfilled, and the king at length "had his own again."

Landing of Charles in England.

The Restoration of 1660.

XXXV.

THE VERB (*continued*).

Practical Application (continued).

III. Model of a verb in *ger*, conjugated negatively:—

INFINITIVE.

Present—ne pas manger, *not to eat.*
Past—n'avoir pas mangé, *not to have eaten.*

PARTICIPLES.

Present—ne mangeant pas. *not eating.*
Past—mangé, *eaten*; n'ayant pas mangé, *not having eaten.*

INDICATIVE.

Present.	*Imperfect.*
je ne mange pas,	je ne mangeais pas,
I am not eating.	*I was not eating.*
tu ne manges pas,	tu ne mangeais pas,
il ne mange pas,	il ne mangeait pas,
nous ne mangeons pas,	nous ne mangions pas,
vous ne mangez pas,	vous ne mangiez pas,
ils ne mangent pas.	ils ne mangeaient pas.
Perfect Definite.	*Future Absolute.*
je ne mangeai point,	je ne mangerai point,
I did not eat at all,	*I shall not eat at all.*
tu ne mangeas point,	tu ne mangeras point,
il ne mangea ,,	il ne mangera ,,
nous ne mangeâmes point,	nous ne mangerons point,
vous ne mangeâtes ,,	vous ne mangerez ,,
ils ne mangèrent ,,	ils ne mangeront ,,

COND. *Present.*	IMPERATIVE.
je ne mangerais jamais,	
I should never eat.	ne mange jamais,
tu ne mangerais jamais,	*do thou never eat.*
il ne mangerait ,,	qu'il ne mange jamais,
nous ne mangerions jamais,	ne mangeons ,,
vous ne mangeriez ,,	ne mangez ,,
ils ne mangeraient ,.	qu'ils ne mangent jamais.

SUBJUNCTIVE.

Present.	*Imperfect.*
que je ne mange guère,	que je ne mangeasse plus,
that I may hardly eat.	*that I might not eat any more.*
tu ne manges guère,	tu ne mangeasses plus,
il ne mange ,,	il ne mangeât ,,
nous ne mangions guère,	nous ne mangeassions plus
vous ne mangiez ,,	vous ne mangeassiez ,,
ils ne mangent ,,	ils ne mangeassent ,,

Compound Tenses.—These are added not because they illustrate any particular point in connection with verbs in *ger*, but because it is desirable that the learner should possess a complete pattern of verbs conjugated negatively.

INDICATIVE.

Perfect Indefinite.

je n'ai pas mangé, *I did not eat*, or *I have not eaten, etc.*
tu n'as pas ,,
il n'a pas ,,
nous n'avons pas mangé
vous n'avez ,, ,,
ils n'ont ,, ,,

Pluperfect.

je n'avais point mangé, *I had not eaten at all, etc.*
tu n'avais ,, ,,
il n'avait ,, ,,
nous n'avions point mangé
vous n'aviez ,, ,,
ils n'avaient ,, ,,

Perfect Anterior.

je n'eus pas plus tôt mangé que, *I had no sooner eaten than . . . , etc.*
tu n'eus ,, ,, ,, ,, ,,
il n'eut ,, ,, ,, ,, ,,
nous n'eûmes pas plus tôt mangé que
vous n'eûtes ,, ,, ,, ,, ,,
ils n'eurent ,, ,, ,, ,, ,,

Future Anterior.

je n'aurai guère mangé, *I shall not have eaten much, etc.*
tu n'auras ,, ,,
il n'aura ,, ,,
nous n'aurons guère mangé
vous n'aurez ,, ,,
ils n'auront ,, ,,

CONDITIONAL.

Past.

je n'aurais jamais mangé, *I should never have eaten,*
tu n'aurais ,, ,, [*etc.*
il n'aurait ,, ,,
nous n'aurions jamais mangé
vous n'auriez ,, ,,
ils n'auraient ,, ,,

Other Form.

je n'eusse jamais mangé, *I should never have eaten, etc.*
tu n'eusses ,, ,,
il n'eût ,, ,,
nous n'eussions jamais mangé,
vous n'eussiez ,, ,,
ils n'eussent ,, ,,

SUBJUNCTIVE.

Perfect Definite.

que je n'aie pas mangé, *that I may not have eaten, etc.*
que tu n'aies ,, ,,
qu'il n'ait ,, ,,
que nous n'ayons pas mangé
que vous n'ayez ,, ,,
qu'ils n'aient ,, ,,

Pluperfect.

que je n'eusse pas mangé, *that I might not have eaten,*
que tu n'eusses ,, ,, [*etc.*
qu'il n'eût ,, ,,
que nous n'eussions pas mangé
que vous n'eussiez ,, ,,
qu'ils n'eussent ,, ,,

IV. Model of a verb in *cer*, conjugated interrogatively in those tenses which admit of it, with accompaniment of objective personal pronouns :—

INFINITIVE.

Present—placer, *to place*
Past—avoir placé, *to have placed.*

PARTICIPLES.

Present – plaçant, *placing.*
Past—placé, *placed;* ayant placé, *having placed.*

INDICATIVE.

Present.	*Do I place him, or it?*	*Perfect Definite.*	*Did I place her, or it?*
le placé-je? *or*		la plaçai-je?	
est-ce que je le place?		la plaças-tu?	
le places-tu?		la plaça-t-il?	
le place-t-il?		la plaça-t-elle?	
le plaçons-nous?		la plaçâmes-nous?	
le placez-vous?		la plaçâtes-vous?	
le placent-ils?		la placèrent-ils?	

Imperfect.	*Was I placing them?*	*Future Absolute.*	*Shall I place some?*
les plaçais-je?		en placerai-je?	
les plaçais-tu?		en placeras-tu?	
les plaçait-il?		en placera-t-il?	
les placions-nous?		en placerons-nous?	
les placiez-vous?		en placerez-vous?	
les plaçaient-ils?		en placeront-ils?	

COND. *Present.*	IMPERATIVE.
y placerais-je?	
should I place there?	
y placerais-tu?	place-le, *place him.*
y placerait-il?	qu'il la place, *let him place her.*
y placerions-nous?	plaçons-les, *let us place them.*
y placeriez-vous?	placez-en, *place some.* [*there.*
y placeraient-ils?	qu'ils y placent, *let them place*

SUBJUNCTIVE.

Present.	*Imperfect.*
que je te place,	que j'en plaçasse,
that I may place thee.	*that I might place some.*
que tu me places,	que tu en plaçasses,
qu'il nous place,	qu'il en plaçât,
que nous le placions,	que nous y plaçassions,
que ils vous placent.	que ils y plaçassent.
que vous les placiez,	que vous y plaçassiez,

COMPOUND TENSES.

INDICATIVE.

Perfect Indefinite.	*Have I placed him, or it?*	*Perfect Anterior.*	*Had I placed them (m. pl.)?*
l'ai-je placé?		les eus-je placés?	
l'as-tu ,,		les eus-tu ,,	
l'a-t-il ,,		les eut-il ,,	
l'avons-nous placé?		les eûmes-nous placés?	
l'avez-vous ,,		les eûtes-vous ,,	
l'ont-ils ,,		les eurent-ils ,,	

Pluperfect.	*Future Anterior.*
l'avais-je placée,	les aurai-je placées?
had I placed her, or *it?*	*shall I have placed them* (f. p.)?
l'avais-tu placée,	les auras-tu placées?
l'avait-il ,,	les aura-t-il ,,
l'avions-nous placée,	les aurons-nous placées?
l'aviez-vous ,,	les aurez-vous ,,
l'avaient-ils ,,	les auront-ils ,,

CONDITIONAL.

Past.	*Other Form.*
en aurais-je placé?	y eussé-je placé?
should I have placed some?	*should I have placed there?*
en aurais-tu placé?	y eusses-tu placé?
en aurait-il ,,	y eût-il ,,
en aurions-nous placé?	y eussions-nous placé?
en auriez-vous ,,	y eussiez-vous ,,
en auraient-ils ,,	y eussent-ils ,,

SUBJUNCTIVE.

Perfect Definite.	*Pluperfect.*
que je lui aie placé,	que je leur eusse placé,
that I may have placed for him, for her.	*that I might have placed for them.*
que tu lui aies placé,	que tu leur eusses placé,
qu'il lui ait ,,	qu'il leur eût ,,
que nous lui ayons placé,	que nous leur eussions placé
que vous lui ayez ,,	que vous leur eussiez ,,
que ils lui aient ,,	que ils leur eussent ,,

Remark.—For the first time in these lessons the student has brought under his notice a principle of which many illustrations will yet be given, and this is the agreement of the past participle following *avoir* with the direct object placed before the verb. In the perfect indefinite *placé* agrees with *le*, m.s.; in the pluperfect *placée* agrees with *la*, f.s.; in the perfect anterior *placés* agrees with *les*, m.p.; in the future anterior *placées* is f.p., because *les* stands for a f.p.; in the last four tenses, *en*, *y*, *lui*, *leur*, being *indirect* objects, the past participle is not affected.

XVI.

HYÆNAS.

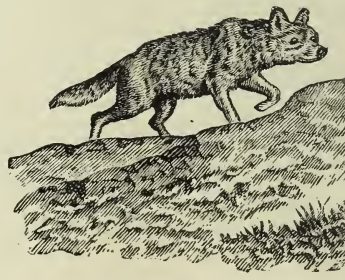
THESE creatures form a family distinct from the cats, in having four additional teeth, making thirty-four in all; these four being additions to the first set of molars. All these are girt with a prominent ridge at the base of the part above the gum, while the apex rises in a massive cone. The sectorial or seissor-teeth well keep up the idea of the carnivorous nature; and very high muscular ridges on the back of the head, and wide and strong bony cheek-arches, indicate the great strength of the muscles attached thereto. The claws, too, differ from those of the cats in not being retractile.

Hyænas.

In size, the hyænas range with the larger dogs, but their coarse and rough coat, and the mean expression of their face, gives them a most unattractive appearance. The spotted hyæna is found over South Africa, and up to the Sahara; it is spotted with black over a yellowish-brown coat. There is a smaller brown hyæna in South Africa; and the striped hyæna is known from Northern Africa to India. These creatures follow the tracks of lions and other slaughtering beasts, picking up the refuse pieces, cracking the long bones for the sake of the marrow with their powerful jaws. If no dead food be attainable, and when he really must hunt for himself, the hyæna is the reverse of a brave warrior, selecting the weakest and timidest prey. Travellers in South Africa not only dislike the prowling, thieving disposition of the hyæna, but also most intensely complain of the torment caused by the disagreeable loud laugh which groups of hyænas persistently keep up near their encampments.

Cowardly character.

Canon Tristram describes the striped hyæna as common in every part of Palestine, hiding in the old rock-hewn tombs, and seeking bones in graves wherever attainable. It is one of the leading scavengers of Egypt and the East. Its name is derived from having vertical stripes or bands of black down both sides upon a yellowish-brown coat.



JACKAL.

Passing over one or two interesting transition forms between cats and the next family, civets, we must deal with these latter with great brevity. Many of them occur in southern Asia and in Africa. They are toe-walkers, but carry the true heel comparatively near the ground. Their claws are only capable of being partially withdrawn into the sheath. Their jaws, like their bodies generally, are much lengthened in proportion to their height; and with less powerful muscles to wield them, they have a dozen more teeth than cats to chew and grind their food. The canine teeth are less prominent, and the grinders are not mere scissor-blades, but have rounded knobs upon them. We may expect to find changed habits in consequence. The name of the group is derived from the fatty solid secretion of a pair of little pouched glands beneath the root of the tail; these yield a powerful rank perfume. The African civet inhabits northern Africa and eastern Asia; the large Asiatic species extends from India to southern China. They are essentially carnivorous, and as they are not much smaller than hyænas, they readily conquer birds and small quadrupeds. The genette is not only common in northern Africa, but in the southern parts of Europe, and it is capable of domestication, and of serving man by catching mice.

The civets.

The ichneumon is a member of this group, noted for eating crocodiles' eggs, sucking the blood of the birds it kills, and destroying them in large numbers.

The Dog Family.

Dogs, wolves, and foxes—man's faithful companions, his dreaded antagonists, his materials of sport—are at once clearly distinguishable from the cats by their claws and by their greater proportionate length of head. While the fore-feet agree with those of cats in having five digits, the hinder have but four toes. A dog's toes have claw-like nails, but they are not capable of being withdrawn into a sheath, nor are they so sharp as a cat's. Thus we see why dogs, wolves, and foxes seize their prey with their teeth rather than strike or tear with their paws. The teeth of the dog are more numerous than those of a cat, reaching as many as forty-two. The eye-teeth or canines are of considerable size, but much less effective than those of a tiger, while the cutting and grinding teeth behind them are, in all, six above and seven below in each jaw. While preserving that characteristic feature in the flesh-eaters, the possession of specially developed cutting or scissor-like teeth, dogs have more teeth both in front and behind than the cats.

Feet and claws.

Teeth.

Wild dogs have been known in nearly all parts of the world, whether as domestic dogs run wild, or as forms which have never been domesticated; but no doubt the chief interest of dogs lies in their attachment to man, and in the endless varieties of outward appearance and of faculty that they have displayed. The dog, however, would seem to have failed to force his way into full recognition of his capacity, among some races. The antipathy between the Jews and dogs is not very easily accounted for. The law of Moses declared a dog "unclean," and comparison with "a dead dog" was used as a most contemptuous expression by David and other distinguished Hebrews. This dislike and disregard of dogs, shown in full force by Hindoos and Mahometans of the present day, is in striking contrast with the veneration and worship manifested by the ancient Egyptians. The latter, as proved by various works of art, knew several varieties of dogs; while the Greeks and Romans were acquainted with many forms of hounds, as well as house-watchers and pet-dogs. But it is believed by many students of the early traces of mankind, that long before man became so civilised as to be capable of leaving written records behind him, the dog had already been domesticated—even in the long-past period of flint-implements.

Attachment to man.

Dislike of some races.

Very early domestication.

Many savage tribes, both in the old and new world, have worshipped the dog, and also have used him as a sacrificial victim. The horrible sacrifices of dogs by the old Scandinavian peoples strike us as strange manifestations of human nature, when viewed side by

side with the conduct of an ancient people on the banks of the Caspian Sea, who considered it one of the strongest expressions of respect to leave the corpses of their friends to be devoured by fierce dogs. Mankind might be divided into dog-venerating and dog-hating peoples; and it would seem but a step farther in regard to the Chippeway Indians, who believe themselves sprung from a dog. Among these and other peoples, there seems to be no instinctive dislike to allowing an animal origin for man's physical nature, such as has been displayed in modern times by many among civilised races.

Worship of and regard for dogs.

The best scientific opinion now-a-days considers that dogs have been tamed at many periods by widely-distant peoples, from wild species which have been more or less distinctly dogs, wolves, or jackals; that these have been intermingled and intercrossed in all imaginable ways; and that with this complexity of origin it is not surprising that the dog is still so variable, so sensitive in nature, so fitted to be the companion and assistant of man.

Complex origin of dogs.

SEAL. ESQUIMAUX DOG.

At the present day, there is no doubt that tame dogs in many regions closely resemble the wolves or wild dogs of the neighbourhood. Wolves have again and again been mistaken for dogs, both in appearance and in cry. Barking appears to be only the civilised form of the wild howl; it is often forgotten by dogs which run wild; it has been acquired by wolves and jackals.

Let us now illustrate dog-nature by a few new anecdotes. A little Scotch terrier belonged to a tradesman living in a town about eighty miles from Liverpool, to which place the man removed, leaving the dog in charge of a friend. The latter, however, was dismayed to find the dog missing next day. A week afterwards the poor animal presented himself, half-famished, and with bleeding feet, at his master's new abode in Liverpool. This dog had *never* been to Liverpool.

Discovery of master's new home.

An English terrier named "Lady" knew the days of the week perfectly well. When her master, of whom she was very fond, went away, she was told on which day he would return, and on the day named, without fail, she started to meet him.

Knowledge of days of week.

A Scotch-and-Skye terrier, named "Rosa," for some reason had a perfect hatred of Lord Macaulay's poems, and not a line written by him could be quoted in her presence without violent demonstrations of rage on her part. Her young mistress habitually read aloud to her, and told her tales; Rosa always cried at the sad parts and barked at the merry ones. She was extremely fond of music, and jumped into the young lady's lap when she was at the piano. One day Rosa was found on a chair by the piano crying and licking the keys, and moving one paw up and down them, as if trying to produce the sounds she loved.

Sensitiveness to music and poetry.

We must find space for a few other typical stories. A Newfoundland dog which, being sent to fetch two hats across a stream, and finding they could not be conveniently carried separately, placed the smaller of the two hats inside the other, evidently showed reasoning power.

Reasoning power.

A French gentleman trained his dogs to understand his words when spoken rapidly, so that they could instantly choose cards of a given colour; they could play at dominoes, and even win a game. When a wrong domino was played by his opponent the dog would growl and bark, and finally remove the wrong domino and play a correct piece from his own set.

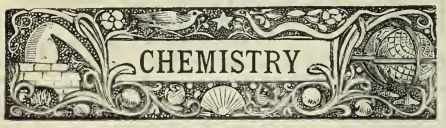
Playing games.

Mr. Romanes's famous terrier, a most sensitive one (never punished), once when left shut up in a room tore the bottoms of the window curtains to shreds. When his master returned, he welcomed him joyfully; but when Mr. Romanes picked up one of the torn shreds, the terrier gave a howl and rushed out of the room, conscience-stricken. He was never known to steal but once, and then, when very hungry, he took a mutton-chop. Mr. Romanes saw the chop brought and laid beneath a sofa, where the terrier remained for a quarter of an hour, not eating, but meditating. At last, conscience won, and the stolen chop was brought and laid at his master's feet. The dog rushed back to his station under the sofa, whence he could by no persuasion be induced to emerge for several hours after. Among other qualities developed in this dog were sensitiveness to ridicule, sympathy for other dogs, and even for other animals, when ill-treated, and extreme honesty.

But alas! dogs may have their morals perverted, and be taught to become most expert accomplices of thieves. A sheep-dog described by Sir Walter Scott had been so trained that he would by night, and stealthily, drive off sheep which

Canine depravity

his master desired, and which had been pointed out to him. The many stories of canine depravity that might be got together can mostly be explained either as instances of the quickness of dogs to imitate and adapt themselves to the characters of those by whom they are surrounded, or the influence of mixed and mongrel ancestry in producing uncertainty of disposition or positive bad qualities. We must express a decided opinion that dogs which show exceptionally good qualities are either the property of people of high moral tone or excellent as educators, or that their ancestors have been so trained.



XLI.

Fats and Oils.

These bodies, whether of animal or vegetal origin, differ from the class of hydro-carbons properly so called, inasmuch as they contain a portion of oxygen which varies with the different classes of those substances. Unlike those organic compounds we have recently considered, albumin and gelatine, they are destitute of nitrogen. The fats and oils, although presenting to the eye an appearance of homogeneity, are in reality composite bodies. If we press a small piece of mutton fat or suet between two sheets of blotting paper, and renewing the paper continue to do so until it ceases to leave any greasy mark or stain on the paper, we shall find a white brittle solid remains behind, to which the name of stearine is given—a term which denotes the solid portion of fats as distinguished from the fluid oleine. In the eye of the chemist every fat is in reality a compound body, consisting of an acid united to a base. The part of the latter is in the case of these bodies filled by the compound glycerine, united to oleic, stearic, and in the case of vegetal oils to palmetic acid. Glycerine is a substance too well known in the present day to need description; it takes its name from the Greek word for sweet. The oils may be divided into two classes: the volatile, and the permanent or fixed oils. An oil of the former class, if dropped upon paper quickly evaporates, leaving no mark behind it, while one of the latter class leaves a permanent greasy stain. The flavouring principle of fruits and the scents of flowers are to be ascribed to the presence in these bodies of small quantities of volatile oils which may be removed by distillation. Eau de Cologne, lavender water, and other fragrant essences, consist of small quantities of volatile or essential oils dissolved in alcohol. The fixed or permanent oils cannot be evaporized or removed by distillation, and may be divided into two classes, the drying and the non-drying oils. All oils absorb oxygen from the atmosphere; but while the former of these classes become resinous by so doing, and eventually hard and dry to the touch, the latter become rancid and continue sticky. It is evident that only a drying oil can be made use of by the painter. Linseed oil is an oil of this character, while olive oil is an unctuous or non-drying oil. Oils of the drying kind are employed in the manufacture of varnish.

Natural fats and oils.

Fats destitute of nitrogen.

In reality composite bodies.

Nature of their components.

Fats contain an acid and a base.

Glycerine the base.

Volatile and fixed oils.

Essential oils.

Permanent oils cannot be evaporized.

Drying and unctuous oils.

Manufacture of varnish.

The Manufacture of Candles.

The discovery of the compound nature of of fats and oils—of the fact that these bodies, like the salts, are in reality composed of a base, glycerine, united to an acid, stearic—wrought a wonderful improvement in the process of candle-making. The old-fashioned dip, or tallow candle, made of crude mutton fat, greasy and foul-smelling, has been replaced by an article that for cleanliness and purity may vie with wax or spermaceti. It was formerly supposed that only the solid fats—those which naturally assume the solid form at ordinary temperatures—could be employed in the manufacture of candles; and the dip or mould tallow candle of the past was made, in the case of the former, by dipping the cotton wick in melted tallow and allowing the fat to congeal upon it, and then repeating the process until a sufficient thickness was attained; and in that of the latter by pouring the molten fat round the wick suspended in a mould. The discovery of the compound nature of fats and oils showed that the latter class of bodies, although containing less of the solid stearine or margarine than the fats, were nevertheless available for the purposes of candle-making. Palm oil is now extensively used for this purpose, as well as cocoanut oil. In the early days of stearine candle manufacture considerable difficulty was experienced in overcoming the tendency of that compound to crystallize. To counteract this, arsenic, or rather arsenious acid, was added to the molten fatty acids. This was, however, attended by a serious drawback, as the fumes given off by such candles in burning were found to be unhealthy. At present crystallization is prevented by the simple expedient of casting the candles—that is, turning the substance of which they are made into the mould just as it is about to set or become solid, care being likewise taken that the mould is

Improvements in candle making.

The old-fashioned dip.

A mistaken idea.

Manufacture of dip and mould candles.

Oils available for candle making.

Palm oil.

Tendency of stearine to crystallize.

Use of arsenic.

Its use superseded.

not of a higher temperature than the semi-fluid stearine. The good qualities of a candle are largely dependent on the nature of the wick. This may be regarded as a sheaf of small capillary tubes which draw up the liquid fatty matter of the candle, and supply the flame with the aliment it requires. As long as the wick is surrounded by the flame it is hindered from coming into contact with the free oxygen of the atmosphere, and is therefore only charred or carbonized, and not burnt. Such a wick will therefore require constant snuffing; to obviate the necessity for which several expedients were adopted. The wick was so twisted that by becoming uncoiled in burning its ends were brought into contact with the atmosphere, or by giving the entire wick a tendency to bend on one side, the same result was accomplished. The last improvement was to steep the entire wick in a solution of borax, which substance, fusing with the minute portion of silica and other earthy matters in the wick, forms at the summit of the latter tiny beads of a kind of glass; which, falling off from time to time, offer no impediment to the combustion, nor in any way impair the illuminating powers of the candle.

Nature of the wick.

Its function.

Not thoroughly burnt.

Necessity for snuffing.

Attempts to overcome this necessity.

The employment of borax.

The Manufacture of Soap.

The fats and oils being composed, as we have already seen, of stearic or oleic acids united to the base glycerine, it should follow that these compounds, like others of the same class—namely, salts—ought to be ready to yield up their base glycerine in favour of some other base for which the fatty acids have a stronger affinity. This reaction actually does take place under proper conditions, and the resulting salt is a soap differing in its properties according to the base employed, this being in every case one of the alkalies. Every one is aware that a solution of ammonia may be made use of to remove grease stains from cloth and other fabrics. This is effected in the following manner. The alkali ammonia unites with the grease to form a soap, which can readily be removed from the cloth by merely washing. The saponification of the fats consists, in fact, in converting them from compounds insoluble to others soluble in water. Bodies precisely analogous to soaps in their composition may be made by employing any of the alkaline earths, or even the oxides of many of the other metals, as bases; but such soaps are practically of no value. The curdiness produced by hard water, as it is termed, when used with ordinary soap in washing, is due to the formation of lime soap, an insoluble compound. This tendency may be counteracted by the employment of one of the alkalies in washing, potash being generally used for the purpose. The latter substance, as well as soda, yields a good detergent soap, but in the case of the combination of potash with a fatty acid we have soft, and in the case of soda hard soap. Common yellow soap derives its colour and odour from the admixture of resin with the oleaginous and alkaline ingredients of soap. Fancy soaps can readily be dyed of any colour, and an agreeable scent imparted to them by the employment of some perfume or fragrant essence. Transparent soaps are prepared by dissolving the materials of which they are composed in alcohol instead of water.

Glycerine replaced by another base in soaps.

Nature of a soap.

A true salt.

Grease stains and ammonia.

Soaps soluble in water.

Insoluble soaps.

Soap curdled by hard water.

Potash and soda in soap.

Yellow soap.

Fancy soaps.

Transparent soaps.

END OF "CHEMISTRY."

XXXIX.

Greece—Empire of Athens (*continued*).

Two great walls or embankments, called "the Long Walls," some sixty feet high, and running parallel to each other with a space of nearly two hundred yards between them, had been built some time before the period at which we concluded our last article. They ran from Athens to its port Piræus, and being easily defended they enabled the Athenians to keep up communication with their seaport even when a hostile army surrounded Athens. By this means Athens could be supplied with unlimited provisions and munitions of war even when besieged, provided their fleets were superior at sea. Perikles, when the war broke out, knowing the relative weakness of his troops on land, urged the Athenians to retire within their city, leaving the Spartans to deal as they liked with the country round, thus avoiding the risk of a battle and wearing out the invaders. The Athenian fleet, in the meantime, could make rapid descents on the Peloponnesian coasts, inflicting considerable loss.

The Long Walls.

The Athenians followed his advice, and when the Spartans invaded Attica in the first year of the war they found no enemy to meet them in pitched battle. They ravaged the crops, and in winter returned to their own country. Next year the same thing occurred, but a great calamity befell Athens. A fearful plague broke out among the crowded inhabitants of the city, and carried off more than one-fourth of them. Perikles lived through it, but many of his friends and possible successors in power were carried off, and he himself died the next year, before the people had recovered their spirits

Spartans invade Attica.

Plague at Athens.

Death of Perikles.

after this sad event. Perikles had so long been the one great Athenian, so implicitly followed and adored, (except for one short period of unpopularity, which passed away before his death,) that there was no statesman accustomed to responsible power ready to take his place. His training of the people had not yet produced that political wisdom and moderation which he expected, and which was necessary for the management of the state. In Athens, at that time, the generals, admirals, and all the great officers of state, civil and military, were elected directly by the Assembly of the people, in which the poorest and most ignorant citizen's vote was as good as that of the richest and wisest. The natural consequence was, that whoever made himself most popular, or could impress the people most with his "speechifying" (and every one had a right to speak in the Assembly), got himself elected to a post of authority and importance, for which often he had not had any training, and was totally unfit.

A class of men of this kind soon sprang up after Perikles was gone. They were called "Demagogues," (or people-leaders—from *demos* = people, and *agōgos* = leader). The name ought to be an honourable one, for no man could desire anything nobler than to be a true leader of the people. Unfortunately it turned out that these would-be leaders were too often only *mis*-leaders of the people, and so the name "demagogue" came to have that unpleasant association which clings to it to this day. Of this new class of demagogues the most conspicuous in Athens at this time was one Kleon, a tanner—a coarse, loud-mouthed, ignorant bully, not without some considerable talents, at least for talking—who gained great influence in the Assembly, where his voice was for ever to be heard, reviling the authorities, and showing how much better he himself would have acted.

The Demagogues.

The Spartans, five times in different years, forced the Athenians to retire within their walls. They besieged the little town of Platæa in the third year of the war, and after a gallant defence it fell. The little garrison, of 400 Platæans and 80 Athenians, held out till food ran short. Then some of them decided to cut their way through their besiegers. One dark and stormy night they issued out of the town, each man with a ladder, by which he scaled the wall the Spartans had built round the town. The whole party, except one man, got through safely, and those who remained in the town were able to hold out longer now that fewer mouths required feeding. However, they were starved out at last, and the Spartans ungenerously put the whole of the inhabitants to the sword and destroyed the town.

Siege of Platæa.

But the barbarity of the Spartans was fully equalled by that of the Athenians in the next year. The large town of Mytilēnē, which had been one of those subject to Athens, threw off the yoke, and was attacked by the Athenian fleet. It surrendered after a long siege, help from Sparta not arriving, and provisions being exhausted, besides that the mass of the people were not strongly opposed to Athens. It was agreed that the fate of the town and its inhabitants should be decided by the Assembly at Athens, and that those who had instigated the revolt should be immediately sent to that city to be judged. When the Assembly met to deliberate on the punishment of the Mytileneans, Kleon proposed that not only the prisoners then in Athens, numbering over a thousand, but also the whole male population of military age, whether they had joined the revolt or not, should be put to death, and the women and children sold into slavery. This revolting proposition was actually carried, and the same day a trireme was sent off to Mytilene with the order for its execution. Happily for the good name of Athens, the Assembly was in a less savage mood next day; the cruel order was recalled, in spite of Kleon's efforts, and a fast-sailing trireme was despatched to overtake the one which had already started. The message of mercy arrived only just in time, and Mytilene was saved, but the prisoners already in Athens were put to death.

Capture of Mytilene.

In the years 426 and 425 the Athenians gained some brilliant victories over their enemies. One of these was the capture of the island of Sphakteria, where the Spartans had placed a garrison. In this garrison were many members of the noblest Spartan families; and their surrender was a great blow to Spartan *prestige*. It proved to the world that Spartans did not always die rather than surrender. The bitterest part of it must have been that they had to surrender to a low-born demagogue—Kleon, the tanner—who had lately been appointed to the command of the expedition, half by way of practical joke to punish him for his boastfulness. He had been taunting the generals in command for not bringing the expedition to an end more speedily, and had declared that if he were in command he would reduce the garrison to submission and bring them all to Athens in twenty days. They took him at his word, and much to his surprise and embarrassment he was obliged to take the command, for he could not refuse the challenge which he had brought on himself. Fortune favoured him, for when he arrived at the island he found that Demosthenes, the general actually conducting the siege, had reduced the garrison to a condition in which speedy surrender was inevitable, and Kleon was able to make good his boast and bring the Spartan garrison to Athens within the twenty days; but every one knew that the real credit of the affair belonged to Demosthenes.

Sphakteria.

The success of the Athenians made them less prudent in their plan of carrying on the war, and induced them to adopt a more ambitious one. They ventured to assume the aggressive on the mainland, instead of contenting themselves with attacking their enemies at sea or near the coast, where their fleet could help their army. They were thoroughly beaten by the Spartans under their general Brasidas, and both Brasidas and Kleon were killed.

In the next year (421 B.C.) a peace was patched up, which, however, lasted only a few years.

Truce.

When war broke out again the Athenians were still very powerful and ambitious, and in an evil hour they listened to a scheme for founding a new empire for themselves in Sicily, where there was already a very strong Greek colony, ruled over by a tyrant, who, like all the tyrants, was more favourable to aristocratic Sparta than to democratic Athens.

Expedition against Sicily.

The evil genius of Athens on this occasion was a young noble named Alkibiades. He was ambitious, daring, clever, but utterly unscrupulous and selfish. His insolence and contempt for legality knew no bounds, but he had unusual abilities also, and possessed great influence with the common people, whom he flattered and dazzled by his brilliant audacity. He was opposed by Nikias, the leader of the nobles, a cautious, honourable, and patriotic man. Unfortunately, Nikias was slow and lacked decision of character, and while deliberating how to prevent Alkibiades from doing a foolish thing, the thing was done.

Alkibiades.

In the year 415 B.C., a great fleet of over 130 triremes and 500 transports, having a powerful army on board, sailed from Greece to attack Syracuse, the chief city of Sicily. Nikias, Alkibiades, and Lamachus were appointed to command it. Unfortunately for its success, Alkibiades, the ablest general of the three, was recalled, almost immediately, on some heavy charges, which no doubt were well founded. The management of the expedition thus fell to Nikias, who had not dash enough for so bold an enterprise. To make matters worse, Alkibiades, instead of returning to Athens, took refuge at Sparta, and now in revenge bent all his energies to ruin his own country. By his advice, a Spartan general, Gylippus, was sent to help the Syracusans. On his arrival, Gylippus found Syracuse in a perilous position, but his energy and skill gave her defenders new courage, and in a very short time the tables were turned, and the Athenians decided to give up the expedition and return home at once. Unhappily they did not carry out this decision, for the very evening before the day appointed for their departure there was an eclipse of the moon, which Nikias, who was very pious, or as we should now say, very superstitious, believed to be a divine warning to postpone his departure for a month. But the Syracusans were now so elated by the turn of affairs, that they determined not to let the Athenians escape. They blocked the harbour in which the fleet lay, and with great energy got ready a fleet to oppose the Athenians. The Athenian fleet, after a desperate effort to break through, was driven back. To force their way through was now impossible, and the survivors, to the number of 40,000 men, abandoning their ships and their dead and dying companions, struck inland, hoping to make their way across the island to some friendly port, whence they could get sent home. But after wandering for a week, suffering the severest privations from hunger and thirst and disease, and the attacks of the pursuing Syracusans, those who remained alive were taken prisoners and sold for slaves. Nikias and his far abler colleague, Demosthenes, killed themselves to avoid intolerable disgrace. Thus ended this ambitious project.

Siege of Syracuse.

Abandonment of the expedition.

No such disaster had ever before befallen Athens. Affairs indeed looked badly for her now. Several of her subjects in the Ægean Sea and several also in Asia Minor revolted and joined the Spartans, who were shortly after

REHEARSAL OF A GREEK COMEDY.

joined by the Persians, in the hope of reconquering Ionia for themselves. to which the Spartans promised to offer no objection.

But the wonderful elasticity of the Athenians, which must ever excite admiration, was not yet spent. By immense efforts they raised another powerful fleet, and defeated the combined fleets of Persia and Sparta.

The alliance between the Persians and Spartans had been brought about by the traitor Alkibiades; but he soon made enemies for himself in Sparta, and was obliged to fly to the Persians. He now began to plan an elaborate scheme for securing his own return to Athens. He sent word to some of the leaders of the oligarchical party in Athens that he could and would break up the alliance of Persia with Sparta on condition that he was allowed to return in safety, but that he could not consider himself safe so long as the government of Athens remained a democracy. A conspiracy among the nobles in Athens succeeded in overthrowing the democratic government and setting up a new form of oligarchy, consisting of four hundred men of their own party, who usurped all the powers of government.

Government of the "Four Hundred."

Alkibiades meantime remained at Samos, and being invited by the popular party there to be their leader, he calmly deserted the Athenian conspirators who had acted on his advice. The Four Hundred did not manage things well, and in a very short time were driven out, and the old form of government was restored; but payment to jurors was abolished, and a property qualification for voters was established. This happened in the year B.C. 411. What events followed these changes we shall see in our next article.

Old form of government restored.

XLIII.

Square Root.

We have seen how to find the area of a square or a cube when the length of one side of the square or cube is given. We have now to explain a method of performing the converse operation—namely, to find the length of the side of a square or cube when the area of the square, or volume of the cube, is given.

Definition.—*The "Square root" of a number is that number which, when multiplied by itself* (i.e. "*squared*"), *gives as product the original number.*

Thus the square root of 25 is 5, because 5 multiplied by itself gives as product 25.

Definition.—*The "Cube root" of a number is that number which, when multiplied by itself twice, gives as product the original number.*

Thus the cube root of 125 is 5, because $5 \times 5 \times 5 = 125$.

It is evident that

The square root of			1	is	1
,,	,,	,,	100	,,	10
,,	,,	,,	10,000	,,	100
,,	,,	,,	1,000,000	,,	1000

and so on.

Thus we see that the square root of any number between 1 and 100 is a number between 1 and 10—*i.e.*, it must be a number whose integral part has only one figure. The square root of any number between 100 and 10,000 is a number between 10 and 100—*i.e.*, it must be a number whose integral part has two figures; and so on. By considering this, the student will see that if a dot be placed over the units place of any number, and thence over every second figure to the left, the number of dots will be the same as the number of figures in the square root of the number.

The following rule, long and difficult as it is, is the best we can give for finding the square root of any given number:

Place a dot over the units figure of the given number, and over every second figure thence towards the left. The figure under any dot, and the figure to the left of it, together form a "period."

Find the greatest number whose square is contained in the first *period*—(i.e. *the period at the extreme left*). *This number is the first figure of the required root, and may be placed to the right in the form of quotient.*

Square this number, place the square under the first period, subtract, and to the remainder so found bring down the next period.

Divide the number thus formed, omitting its last figure, by double the part of the root already obtained. The quotient is the second figure of the required root.

Annex this figure to the last preceding divisor, and multiply the number so formed by the last figure of the root.

Write this product under the number already formed by the remainder and second period, and subtract. If there are any more periods they are to be brought down period by period, and the above operation repeated each time.

We shall now apply this rule to an example, which will make it intelligible.

Find the square root of 1156:

$$\begin{array}{rl} & 1156(34 \\ & 9 \\ \hline (3 \times 2 = 6) & 64)256 \\ & 256 \\ \hline \end{array}$$

The first period is 11. The greatest number whose square is contained in 11 is 3—(∵ 4 squared is 16, which is too great). Thus 3 is the first figure of the required root. Writing its square, 9, under the period 11, and subtracting and bringing down the next period 56, we have the number 256. Omitting the last figure 6, and dividing the 25 by double the 3 of the root (*i.e.* by 6), the quotient is 4. Thus 4 is the second figure of the root. This 4 is to be annexed to the preceding divisor 6, thus forming the number 64. This number 64 is now to be multiplied by the last figure of the

root (*i.e.* by 4); and the product written under the number 256, formed by the remainder and second period. We now subtract, and as there is no remainder the root is 34 exactly.

Find the square root of 123201 :

$$\begin{array}{rl} & 1\dot{2}3\dot{2}0\dot{1}(351 \\ & 9 \\ \hline (3\times 2=6) & 65)332 \\ & 325 \\ \hline (35\times 2=70) & 701)701 \\ & 701 \\ \hline \end{array}$$

The first period is 12. The greatest number whose square is contained in 12 is 3, ∴ 3 is first figure of the root. Squaring it, and subtracting from first period, we have 3. Bringing down next period we have 332. Omitting the figure 2, and dividing the 33 by double 3 (*i.e.* by 6) we get 5 as the second figure of the root. Annexing this to the divisor 6 we have 65. Multiplying 65 by 5 (the last preceding figure of the root), and subtracting the product from 332, we have remainder 7, to which we bring down the next period 01. Doubling the 25 (the part of the root already obtained) we get our next divisor 70. Omitting the last figure of the number 701, our dividend is 70, and therefore the quotient is 1. Thus the next figure of the root is 1. Annexing this to our divisor 70, we have 701, which, multiplied by the last preceding figure of the root (*i.e.* by 1), and subtracted from our dividend 701, leaves no remainder. Therefore 351 is the required square root.

Find the square root of 164836.

$$\begin{array}{rl} & 1\dot{6}4\dot{8}3\dot{6}(406 \\ & 16 \\ \hline (4\times 2=8) & 806)4836 \\ (40\times 2=80) & 4836 \\ \hline \end{array}$$

In this example, when we subtract 16 from the first period there is no remainder. We bring down the next period, 48. Now we find that our divisor 8 is larger than our dividend 4. We must therefore write 0 as the second figure of the root and proceed according to the rule, or, what is the same thing, simply annex 0 to our divisor 8, bring down the next period 36, and divide the 483 by 80. The quotient is 6; and proceeding in the usual way, we see that the root is 406 exactly. We observe that each figure of the root after the first is got by a process of division, the divisor being "double the part of the root already obtained." This divisor is called a "*trial divisor*," because sometimes the quotient it gives is too large. When this is found to be the case, we must try the next lower number as the required figure of the root.

To find the square root of a decimal, or a whole number and a decimal, we must place the dots over the second figure to the right of the decimal point (*i.e.* over the hundredths) and over every second figure thence towards the *right*. Then proceed as in the case of an integral number, the number of dots over the integral part being the number of figures in the integral part of the root so found. Thus, if we had to find the square root of 316·153, we should place the dots so : 3̇1̇6·1̇5̇3̇0̇, and there would be two figures in the integral part of the root, as there are two dots in the integral part of the given number.

Observe that we have annexed a cypher to the 3 in the decimal part. Of course we may annex as many cyphers as we like, and we must always bring down *two* figures (*i.e.* a "period") at a time. If we do not find an exact square root, we can go on approximating to it as long as we like, bringing down two cyphers at each step, and getting fresh figures in the decimal part of the root.

To find the square root of a vulgar fraction, we may express the fraction as a decimal and find the square root of this decimal by the preceding rules, or we may work it as in the following examples :

Find the square root of $\frac{81}{144}$.

The square root of a fraction is evidently the square root of the numerator divided by the square root of the denominator.

The square root of the numerator is 9, and that of the denominator is 12.

∴ Square root of $\frac{81}{144} = \frac{9}{12}$. This we can easily verify, for $\frac{9}{12}\times\frac{9}{12}=\frac{81}{144}$.

Find the square root of $\frac{7}{8}$.

Here neither numerator nor denominator is a perfect square, but we can make the denominator a perfect square by multiplying numerator and denominator by the denominator. Thus :

$$\frac{7}{8}=\frac{7\times 8}{8\times 8}=\frac{56}{\text{the square of } 8.}$$

∴ the square root of $\frac{7}{8}$ is $=\frac{\text{square root of } 56.}{8}$

We must, therefore, find the square root of 56 to as many places of decimals as we require, and divide the result by 8.

The student can easily manufacture for himself as many examples in Square Root as he wishes, by simply taking any number or fraction, multiplying it by itself, and then applying to the product the rule for finding the square root. The result, if correct, will be of course the original number.

We shall not take up any more space with such examples. Nor shall we try the reader's patience by setting him to puzzle out the rule for extracting the *cube* root. There is such a rule, and the student if he has occasion to learn it will find it given in most arithmetic books; but as it is very difficult, and not of much practical use except in particular professions, we shall not trouble the general reader with it. Indeed, we must now shake hands with our kind friends who have taken an interest in our study of arithmetic, and wish them as much benefit from it as we have derived pleasure. If we all lived in some fairy-land, where unlimited time and space were at our command, we would gladly go on for some time longer with these papers, and possibly you might be willing to study them. But the conditions of life being as they are, we are compelled reluctantly to lay down the pen.

END OF "ARITHMETIC."

XV.

Miscellaneous Examples.

§ 66. Example 4. *A weightless cord is suspended from two points; to certain points weights are attached. Determine the weights when the shape of the cord is given, and when the weights are given find the shape of the cord.*

Fig. 36 will serve as a diagram for these problems. The former is really a very simple one, although at first sight it seems hard. We assume the portions of cord to be straight, and number them 1, 2, etc. The problem is then solved by considering the forces that act upon the points at the junction of the first and second links, at the junction of the second and third, and so on. In each case there are three forces, all passing through the point considered—viz., the tensions of the two links and the weight attached. The triangle of forces for each joint can be formed without difficulty, and in doing so a great simplification will be suggested, which in fact amounts to grouping all the triangles into one figure—namely, that on the right of fig. 36. The line 1—4 in this figure is vertical; o 1, o 2, etc., are drawn from any convenient point o, parallel to the first, second and other links. Then the triangle of forces for the joint between the first and second links is o 12, for the next joint it is o 23, and so on. The weight suspended at the junction of the first and second links is represented by the line 12, that at the next joint by the line 23, and so on. The tension in the first link is represented by o 1, in the second by o 2, and so on. If any difficulty is felt about this, the reader should construct for himself the triangle of forces for each joint. If care be taken to keep the scale the same throughout, it will be found that the triangles fit together and make up the diagram on the right of fig. 36. This compound diagram is chiefly valuable as giving help in the solution of the inverse problem, to which we now proceed.

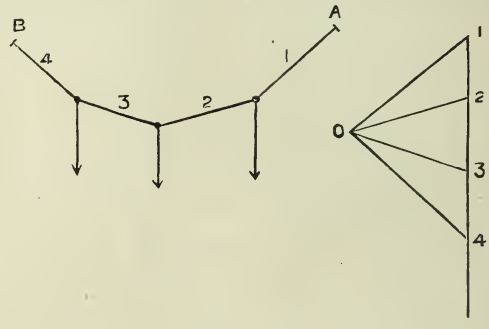


FIG. 36.

The form assumed by a cord to which weights are attached, depends partly upon the weights, partly upon the place to which they are attached, partly upon the length of the cord, and upon the relative position of the points at which the cord is suspended. For if any one of these be altered the form of the cord is altered. If, then, we want to know the shape in which the cord hangs, we must have information on all these points. The determination by drawing is difficult, except when we are given the directions taken by the first and last links of the cord, instead of the positions of the two points of suspension. In this case the construction is very simple. We draw a vertical line, and on it mark off distances 12, 23, 34, proportional to the weights. From 1 we draw a line parallel to the given direction of the first link, from 4 a line is drawn parallel to the given direction of the last link. (Our fig. 36 represents the case of four links only.) The intersection of these lines gives the point o, and by joining o to 2, 3, we complete the diagram of forces.

To draw the figure formed by the string is now easy. We draw from A a line parallel to 1 o, and mark off a length equal to the given length of the first link; from the extremity a line is drawn parallel to 2 o, and the length of the second link is marked off; and so we continue until all the links are drawn. The description of the process is perhaps a little terrible in aspect, but if the student will make a sketch for himself according to the directions given, he will find that the appearance of difficulty is an appearance only. Having done this, let him take other cases, with several 'links,' instead of four, as above. A particularly interesting case is that in which all the links are equal and equally loaded. This gives very nearly the form assumed by a string which hangs from two points, and whose form is determined by its own weight. The more links are taken, the nearer is the result.

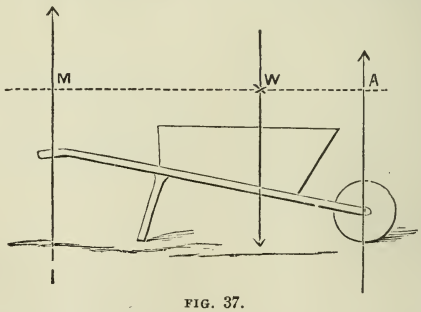


FIG. 37.

§ 67. Example 5. *A man is wheeling a load in a wheelbarrow. Find the force he has to exert, and the pressure on the axle of the wheel.*

Our previous examples have illustrated the case of forces which meet in a point. The present one will deal with parallel forces. The weight-line of the barrow (not including the wheel) and its load is supposed to be the

vertical line through W in fig. 37. The force exerted by the man in lifting the handles is supposed to be the vertical line, and to act along the upright line through M. Since these forces are parallel. the third force must be parallel to them, and it is represented by the vertical line through A. The first condition to be fulfilled is that the two upward forces together must be equal to the weight acting downwards. If, for example, the latter is 90 poundals, the two upward pressures together must amount to 90 poundals.

Wheelbarrow.

The other condition is that the moments about any point must neutralize each other. To deal with this, we draw a line meeting the three force lines at right angles. The position of the line is a matter of no importance. In our figure, M W A is the line. To fix the ideas, let the distance from M to W be 2 feet, and that from M to A be 3 feet, and let us take moments about the point M. The moment of the force through M is nil. The moment of the force through W is found by multiplying that force, 90 poundals, by its distance from M, 2 feet. This moment is 180, and acts clockwise. The moment of the force through A acts counter-clockwise, and, for equilibrium, must also be 180. Hence it is seen that the pressure of the axle must be 60 poundals, because this force multiplied by the distance, 3 feet from M, just gives 180. Knowing the pressure on the axle to be 60 poundals, we infer from the first condition that the force exerted by the man must be 30 poundals.

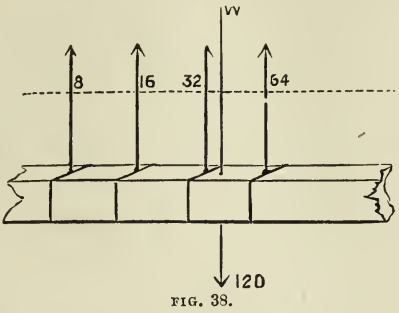


FIG. 38.

It is worth while to verify that the moments about *any* point vanish. Take, for example, the point midway between M and W. The moment of M is 30 clockwise, for the distance is 1 foot and the force 30 poundals. The moment of W is 90, also clockwise. The moment of A is counter-clockwise; and it amounts to 120, for the force is 60, the distance 2. Hence, it appears that the first two moments are just balanced by the last. In the same way it will be found that the moments about any point taken altogether vanish.

If the weight line had been midway between M and A it would have been found that the force exerted by the man, and the pressure of the axle, were each equal to 45 poundals. And thus we get at a result, familiar from every-day experience, that the nearer the load is to a man, the greater the pull he has to exert in order to lift the barrow.

§ 68. Example 6. *A beam is supported by vertical ropes having tensions of* 8, 16, 32 *and* 64 *poundals respectively, at equal intervals. Find the position of the weight line of the beam when in equilibrium.*

First, it is easily seen that the weight of the beam must be 120 poundals. To find the position of the weight line we must take moments. For this purpose we draw a line—the dotted line in fig. 38—perpendicular to the forces, and take moments about the point where it meets the force 8. The moment of this force is nil. That of the second force is 16, of the third 32 × 2 or 64, of the last 64 × 3 or 192. All these moments are counter-clockwise, and they amount altogether to 272. Thus, the moment of the other force, the weight, must be clockwise, and its measure 272. But the weight is 120, and its distance from the moment-point, that is its distance from the force 8, must be a little over 2 of the intervals—the exact number being $2\frac{2}{15}$. The reader may try to solve the problem by taking moments about any other point; and if the work is correctly done he will get the same result as that just obtained. To avoid fractions it may be assumed that each of the distances between the ropes is 30 inches. Then W will be found to be 64 inches from the smallest force, 34 from the second, 4 from the third, and 26 from the greatest force.

Beams.

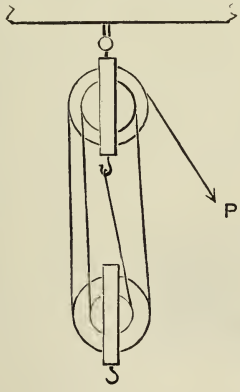


FIG. 39.

§ 69. Example 7. *To explain the effect of pulleys.*

The use of pulleys is a very common expedient for overcoming mechanical difficulties. The form is too well known to require description, and the mode of estimating the force that can be developed by the use of this mechanism is easily deduced from the results we have already exemplified. There is, however, one assumption introduced which must be mentioned. It is that the tension in a rope is the same throughout. If you pull at a rope with a force of, say, 10 poundals, then the rope pulls with that same force at each point of its length. This assumption is not true. For instance, in a rope hanging straight down, the upper part has to support the weight of the whole rope, while at the free end there is no tension. Again, if a rope be twisted once or twice round a pillar, the tension on one side may be vastly greater than that on the other. Indeed, this is familiar to those who have seen a steamboat brought up by the side of a pier. Nevertheless, when the rope passes round a pulley that moves freely, and is not jammed, the assumption is sufficiently near to the truth for all practical purposes.

Pulleys.

Consider now the system shown in fig. 39. Here there are two "blocks," each containing two pulleys. The upper block is fixed, the lower movable. If a force of 1 poundal be applied to the rope at the point P, the tension throughout the rope is 1 poundal. Now consider the forces that act on the lower block. There are four portions of the rope, each pulling upwards with a force of 1 poundal. Hence, these will overcome a single downward force of 4 poundals. The force at P will raise a weight four times as great at the lower block. Thus, a force of 10 poundals at P will raise a weight of 40 poundals, a force of 100 poundals can raise a weight of 400 poundals, and so on. It must not be forgotten, however, that the lower block is raised, as well as the mass attached to it, and the weight of the block must be taken into account. If, for instance, the lower block weighed 3 poundals, a force of 1 poundal would only raise a weight of 1 poundal in addition to the block; a force of 10 poundals would overcome an additional weight of 37 poundals; and 100 poundals would suffice to raise a mass weighing 397 poundals.

It is easy, when we know the weight to be raised, to calculate the requisite force. Suppose we want to raise a mass whose weight is 41 poundals (the lower block weighing 3 poundals) by means of the pulleys shown in fig. 39. The downward forces amount to 44 poundals. Each of the four parts of the rope that pull up bears the same share. That is, the tension in each part is 11 poundals, and this is the force required.

Sometimes—but this happens more often in books than in practice—the force exerted by the lower block is applied not to raise a heavy mass but to pull at a rope working round another set of pulleys. The calculation of the effect of such an arrangement presents no difficulty. For if we know the force at P we can find the force exerted by the lower block; knowing this we can calculate the force exerted by the movable block of the second set of pulleys, and so on.

XLIV.

STUDY FOR READING AND PRONUNCIATION.

Der Paradiesvogel;—Fortsetzung.
dare pah-ra-deeee'-fo'-gel fort'-sets-ung
THE BIRD OF PARADISE CONTINUATION.

Der gemeine Paradiesvogel ist der
dare ge-wy'-ne pah-ra-deeee'-fo'-gel ist dare
The common bird of Paradise is the

schönste; wann[1] er in dem Glanze
shoen'-ste vaun er in dame glant'-se
most beautiful; when he in the brightness

einer südlichen Sonne durch die Luft
i'-ner sued'-lich-en zon'-ne doorch dee luft
of a southern sun through the air

fliegt, übertrifft[2] er an Pracht und
fleecht ue-ber-trifft airr an pracht unt
flies, surpasses he in splendour and

Farbenschmelz,[3] mit Ausnahme[4] des
farr'-ben-shmelts mit owss'-nah-me des
colour-sheen, with exception of the

Kolibri's, wohl alle seiner Gattung.[5]
ko'-lee-brees vole al'-le zy'-ner gat'-tung
humming-bird, well all of his kind.

Er erreicht die Größe einer
airr er-ryeht' dee groess'-e i'-ner
He attains the greatness (size) of a

Drossel und findet sich[6] nicht
dros'-sel unt find'-et sich nicht
thrush and finds himself (is found) not

bloß auf Neuguinea, sondern auch auf
bloee owff noi-gee'-nay-ah zon'-dern owch owff
only on New Guinea, but also on

den östlichen Molucken. Er soll
dane oest'-lich-en moh-look'-en airr zoll
the eastern Moluecas. He is said

aber nur auf Neuguinea brüten,
ah'-ber noor owff noi-gee'-nay-ah brue'-ten
however only on New Guinea to breed

und von dort mit dem Westwind oder
unt fon dorrt mit dame vest-vint oh'-derr
and from there with the west wind or

dem trockenen Mousson nach der Insel
dame trok'-en-en mous-son' naeh dare in'-zel
the dry monsoon to the island

Aru kommen, und dann mit dem Ostwind
ah'-ru kom'-men unt dann mit dame ost'-vint
Aru to come, and then with the east wind

oder dem feuchten Mousson wieder
oh'-derr dame foicht'-en mous-son' vee'der-
or the damp monsoon again

zurückkehren.
tsoo-ruek'-keh'-ren
to turn back.

Es gibt von diesem Vogel eine
ess giept fon dee'-zem foh'-gel i'-ne
There are of this bird a

größere und eine kleinere Abart.[7] Die
groess'-er-e unt i'-ne kly'-ne-re ap'-ahrt dee
greater and a smaller species. The

kleinere ist die zahlreichere[8] und lebt
kly'-ne-re ist dee tsahl'-ry-che-re unt laypt
smaller is the more numerous and lives

in Neuguinea, nicht vermischt mit der
in noi-gee'-nay-ah nicht fer-misht mit dare
in New Guinea, not mixed with the

größeren. Ihre Farben sind lebhafter,
groess'-er-en ee'-re farr'-ben zint layb'-haft-er
greater. Its colours are more lively,

und sie ist nicht größer als ein Häher,
unt zee ist nieht groess'-er als ine hay'-err
and it is not greater than a hawk

dreizehn bis fünfzehn Zoll lang ohne
dry'-tsayn biss fuenf'-tsayn tsoll lang oh'-ne
thirteen to fifteen inches long without

die Drahtfedern. Dieser Vogel gleicht
dee draht'-fay-dern dee'-zer foh'-gel glyeht
the wire feathers. This bird resembles

im Betragen[9] dem Raben, sitzt auf den
im be-trah'-gen dame rah'-ben zitst owff dane
in behaviour the raven, sits on the

Gipfeln der Bäume und versteckt[10] sich
gip'-feln dare boy'-me unt fer-steckt' sich
summits of the trees and hides himself
nur bei der größten Hitze, schreit[11] laut
noor by dare groess'-ten hit'-se shrikt lout
only in the greatest heat, screams loud
woiko, um die Weibchen zu rufen,
voi'-koh um dee vipe'-chen tsoo roo'-fen
Voiko, in order the females to call,
welche ihrer[12] zwanzig und mehr
vel'-che ee'-rer tsvant'-sich unt mairr
which (of them) twenty and more
gackernd auf den andern Bäumen
gack'-ernd owff dane an'-dern boy'-men
cackling on the other trees
sitzen. Diese größere Zahl kommt
zit'-sen dee'-ze groess'-er-e tsahl kommt
sit. This greater number comes
wahrschein=lich[13] daher,[14] daß die
vahr'-shine-lich dah-hare' dass dee
probably therefrom that the
schönen Männchen immer weggefangen
shoeh'-nen menn'-chen im'-merr veck'-ge-fang'-en
beautiful males always caught (away)
werden.
vairr-den
are.

REMARKS ON THE FOREGOING STUDY.

[1] Remark the difference between *wenn*, if, and *wann*, when. The two are often confounded, but they are different. *Wann* is used for the present and future; *als* for the past.

[2] *Uebertreffen* (from *über*, over, and *treffen*, to hit a mark)—thus, to go beyond the usual mark. "*Der Vater trifft den Vogel ju im Flug*," The (my) father hits the bird in its flight.—From Schiller's *Wilhelm Tell*.

[3] *Farbenschmelz*. The word *Schmelz* means literally melting—thus the word means the soft melting of colours into one another.

[4] *Die Ausnahme* (from *aus*, out, and *nehmen*, to take), the taking out or withdrawing from a category.

[5] *Die Gattung*, in natural history the genus. The word, in its wider sense, means that which is associated. Hence the old German expressions—*der Gatte*, the husband, and *die Gattin*, the wife. "*Des Gatten Wunsch verdient doch wohl ein Wenig Achtung*," The husband's wish deserves still probably a little consideration.—KOTZEBUE.

[6] *Er findet sich*, literally he finds himself, an idiomatic expression, like the French *il se trouve*.

[7] *Die Abart*, a compound word from *ab*, off, away, and *die Art*, the kind. Thus we have *der Abdruck*, the printing off; *das Abbild*, the portraiture or representation (off-picturing); *der Abguss*, the casting (pouring off).

[8] *Zahlreich*, literally rich in number; like *Kunstreich*, artistic, rich in art.

[9] *Betragen*, behaviour; literally the carrying of oneself (from *tragen*, to carry).

[10] *Versteckt sich*, literally "sticks himself away."

[11] From *schreien* we have the English to shrick. The word applies only to a loud cry.

[12] The *ihren* here is an idiomatic expression only used in the plural. Thus, *Ich bekomme oft Briefe, Ich habe heute ihrer funfzehn erhalten*—I often get letters, I have received fifteen (of those things) to-day.

[13] *Wahrscheinlich* (from *wahr*, true, and *scheinen*, to appear—that which appears to be true, and is consequently probable or credible.

[14] Note that *her* attached or prefixed to a word has always the meaning *hither*, *towards* the speaker; and that on the other hand *hin* means *hence*, and has a signification of carrying away from the speaker. *Gehen Sie hin, und holen Sie mir das Buch her*, Go you hence (away) and bring me the book hither; *Er kam daher geritten*, he came riding hither; *Er ging dahin*, he went away.

EXERCISE ON THE FOREGOING STUDY.

For Translation into German, to be afterwards compared with the German Version given below, for Correction.

The bird of Paradise is very beautiful. He flies often in the splendour of the southern sun through the air, and there is no bird of his kind, with the exception of the humming-bird, whom he does not surpass in brilliancy of colour. He is as large as a thrush; and New Guinea and the Eastern Moluccas are his home. He is said (er soll) to come to the island (of) Aru with the dry monsoon, after he has bred in New Guinea, and they say (man sagt) that he returns with the east wind or the wet monsoon. These birds are present (vorhanden) in a greater and smaller species. The smaller kind has the most brilliant colours; it is also more numerous than the greater, with which it does not mix (itself). Like the raven, this bird is fond of sitting (sits gladly) on the summits of trees. When the heat of the day is greatest he hides himself under the foliage. His cry is like the word *woiko*. With this call he lures the females, of whom twenty and more sit around on the trees. The beautiful males are often caught; thence it comes that the females appear so much more numerous.

German Version of the above.

[Note particularly that in all subordinate sentences (conjunctive, beginning with daß, that, etc.) the verb is at the end of the clause.]

Der Paradies=vogel ist sehr schön.
dare pah-ra-deece'-foh-gel ist zair shoen
Er fliegt oft in der Pracht der süd=
airr fleecht offt in dare pracht dare zued'-
lichen Sonne durch die Luft, und da ist
lich-en zon'-ne doorch dee luft unt dah ist
kein Vogel seiner Gattung, mit Ausnahme
kine fo'-gel zy'-ner gat'-tung mit owss'-nah-me
des Kolibris den er nicht an Far=
dess koh'-lee-brees dane airr nicht an farr'-
benschmelz übertrifft. Er ist so groß
ben-shmelts ue-ber-trifft airr ist zo gross
wie eine Drossel, und Neuguinea und
vee i'-ne dros'-sel unt noy-gee'-nay-ah unt
die östlichen Molukken sind seine
dee oest'-lich-en moh-luk'-ken zint zy'-ne
Heimath. Er soll nach der Insel Aru
hy'-maht airr zoll nach dare in'-zel ah'-roo
mit dem trockenen Mousson kommen,
mit dame trock'-en-en mous-son kom'-men
nachdem er in Neuguinea gebrütet
nach-dame' airr in noy-gee'-nay-ah ge-brue'-tet
hat, und man sagt daß er mit dem
hat unt man zaacht dass airr mit dame
Ostwinde oder mit dem feuchten Mousson
ost'-vin-de o'-der mit dame foich'-ten mous'-son
zurück kehrt. Diese Vögel sind in
tsoo-rueck' kayrt dee'-ze foh'-gel zint in
einer größeren und kleineren Gattung
i'-ner groess'-er-en unt kly'-ner-en gat'-tung
vorhanden. Die kleinere Art hat die
fore-hand'-en dee kly'-ne-re ahrt hat dee

lebhaftesten Farben; sie ist auch zahlreicher als die größere, mit welcher sie sich nicht vermischt. Gleich dem Raben sitzt dieser Vogel gern auf den Gipfeln der Bäume. Wann die Hitze des Tages am größten ist versteckt er sich unter das Laub. Sein Schrei ist dem Worte voiko ähnlich. Mit diesem Rufe lockt er die Weibchen, welche ihrer zwanzig und mehr auf den Bäumen umher sitzen. Die schönen Männchen werden oft gefangen; daher kommt es daß die Weibchen so viel zahlreicher erscheinen.

layp'-haf-tes'-ten far'-ben zee ist owch tsahl'-ry-cher als dee groess'-er-e mit vel'-cher zee zich nicht ferr-misht glych dame rah'-ben sitzt dee'-zer fo'-gel gayrrn owf dane gyp'-feln der Bäume. Wann die Hitze des Tages dare boi'-me vann dee hit'-se dess tah'-ges am größten ist versteckt er sich unter am groess'-ten ist fer-steckt' airr zich un'-ter das Laub. Sein Schrei ist dem Worte voiko dass lowb zine shry ist dame vor'-te voi'-ko ähnlich. Mit diesem Rufe lockt er die ayn'-lich mit dee'-zem roo-fe loekt airr dee Weibchen, welche ihrer zwanzig und vibe'-chen vel'-che ee'-rer tsvant'-sich unt mehr auf den Bäumen umher sitzen. mairr owff dane boy'-men um-hair' zit'-sen Die schönen Männchen werden oft dee shoe'-nen men'-chen vairr'-den offt gefangen; ge-fang'-en daher da-hair kommt es kommt es daß die dass dee Weibchen vipe'-chen so viel zo feel zahlreicher tsahl'-ry-cher erscheinen. er-shy'-nen

RUSSIAN PEASANTRY.

POLITICAL GEOGRAPHY.

IX.

SWITZERLAND.

SWITZERLAND, an inland country of Europe, having north, Germany; east, Austria; south, Italy; and west, France. Lat. 45° 50′ to 47° 50′ N.; long. 5° 55′ to 10° 30′ E. It is about 210 miles in length from east to west, by 140 in breadth, and has an area of 15,982 square miles, or little more than half that of Scotland. Population (1880), 2,846,102, or three-fourths that of Scotland. Switzerland is characterised by the beauty and sublimity of its scenery. Snow-capped mountains look down upon valleys of vineyards and cornfields, while glaciers, avalanches, cataracts, craggy precipices, and deep chasms, all give variety and beauty to the scene.

The southern portion is the most mountainous, where rise Monte Rosa, the culminating point in the country, to 15,217, and the Matternorn to 14,705 feet. In the heart of the country are the Bernese Alps, where the Finsteraarhorn and the Jungfrau rise to 14,026 and 13,671 feet respectively. The Jura mountains extend along the north-west border. The valleys are remarkable for their fertility and beauty, and form a striking contrast to the rugged heights surrounding them. Several important rivers of Europe, as the Rhine, Rhone, Ticino, and Inn, take their rise in Switzerland, but do not attain any great size within the territory. The principal of the other rivers are the Aar, Thur, and Emmen. The lakes are numerous, and many of them are of great extent. The principal are those of Geneva, Constance, Lucerne, Brienz, Thun, Neufchatel, Wallenstadt, Zurich, Zug, and portions of Maggiore and Lugano. The climate varies greatly with the elevation, but is generally severe. The line of perpetual snow is here about 9,000 feet. In the lower parts the climate is pure and healthy, but in some of the deep narrow valleys the heat is oppressive and insalubrious. The vegetable productions are very various, ranging from the vine, orange, olive, pomegranate, to the Alpine herbs, mosses, and lichens. About a sixth part of the surface is covered with forests. The country is more pastoral than agricultural, and cattle, horses, sheep, goats, and swine, constitute the chief wealth of the population. About one-ninth of the land is arable, and though well cultivated, the grain produced is not equal to the wants of the people. The chief agricultural products are wheat, barley, rye, potatoes, flax, and hemp. In some parts the vine is largely cultivated. The forests abound with game, and the rivers and lakes with excellent fish. The mineral wealth is not great. Coal and iron are found in some parts, and mines of lead, copper, and zinc are wrought. Salt is also obtained. The chief manufactures are woollen, linen and cotton goods, silk, leather, watches and jewellery. Several of these have made considerable progress within the last few years. Switzerland also carries on an important trade, although it has few facilities for that purpose. The chief exports are woollen, cotton, linen and silk goods, lace, watches, jewellery, cattle, sheep, dairy produce, timber, wine; imports, colonial

produce, wheat, salt, leather, raw cotton, hemp, flax. There are 1600 miles of railway in operation.

Switzerland is a confederation of twenty-two distinct cantons. The legislative body is the Federal Assembly, which has the exclusive right of declaring war, concluding treaties of peace, or entering into alliances with other countries. It is composed of a National Council, consisting of representatives chosen for three years by the people in the proportion of one representative for every 20,000 inhabitants in each canton, making 145 in all; and a Council of States of forty-four members, being two for each canton. The Federal Assembly nominates for three years the members of the Federal Council, in whom the executive power is vested. The Federal Tribunal is composed of nine members and the same number of substitutes, nominated by the Federal Assembly for six years. It decides in all civil matters between the cantons. Each canton is independent as regards its internal administration. The regular army amounts to 117,500 men. The estimated revenue for 1881 was £1,629,660, and the expenditure £1,638,220. Education is very generally diffused among all classes. The Protestants number 1,667,109, and the Roman Catholics 1,160,782. German is spoken by 2,030,792, French by 608,007, and Italian by 161,923. The principal towns, with their populations, are: Bern, the federal capital, 44,087; Geneva, 50,943; Zurich, 25,102.

SCANDINAVIANS.

GREEK PEASANTRY.

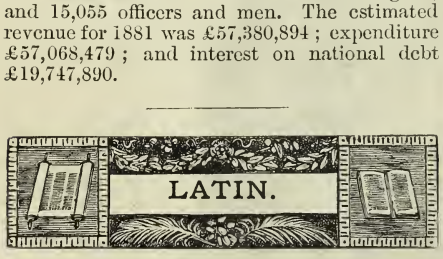
ITALY.

THE kingdom of Italy comprises that country of southern Europe easily recognized from its resemblance to a boot, together with the large islands of Sicily and Sardinia, and numerous smaller islands. It lies between lat. 36° 35′ and 46° 40′ N., and long. 6° 30′ and 18° 30′ E.; and is bounded on the north by the Alps, which separate it from Austria and Switzerland, west by France and the Mediterranean, south by the Mediterranean, and east by the Ionian Sea and the Adriatic. It is about 700 miles in length, and 100 in general breadth, but reaches in the north 380 miles. Area 114,380 square miles; population (1880), 28,437,091. It is divided into 69 provinces; and the largest towns with their populations are Naples, 458,614; Milan, 292,524; Rome, the capital, 289,321.

Italy is separated from the rest of Europe by the Alps, which extend in a semicircular direction from the Gulf of Genoa to the head of the Adriatic. They enclose the fertile and highly cultivated basin of the Po, for the most part a great plain 250 miles in length by 150 in width, and not much above the level of the sea. The Apennines take their rise from the Maritime Alps of France, and traverse the entire length of the peninsula. They send off in their course numerous branches, enclosing valleys, which frequently open out into extensive plains. The highest point is Monte Corno, 9,810 feet. Westward from the main chain, near the Bay of Naples, is the volcano of Vesuvius; and in Sicily that of Mount Etna, which rises to the height of 10,840 feet. The entire country is noted for the beauty and variety of its scenery. It possesses numerous lakes, some of which are of great extent. The principal rivers in the north are the Adige and the Po, with its numerous affluents, the largest of which are the Ticino, Adda, Ogli, and Mincio. The only other river of importance is the Tiber, which flows through Rome. The climate varies considerably in different parts. In the north it resembles that of the adjoining countries, and is of considerable severity; in the central parts it is more genial and sunny, and in the south it is almost tropical. On the whole it is dry, mild, and salubrious, except in a few marshy districts. The chief grain crops are wheat, maize, oats, barley, and rye. Rice is cultivated in the marshy districts in the south, and in the valley of the Po; flax, hemp, cotton, and tobacco, are grown to a considerable extent in many parts. Grapes and olives are generally cultivated, and oranges, lemons,

citrons, pomegranates, figs, peaches, and apricots, are among the other fruits. The sugar cane is also cultivated, and the rearing of the silkworm largely carried on. The horses, cattle, sheep, goats, and swine are numerous. Iron, copper, lead, antimony, and other metals are found, but mining is little attended to. Marble of uncommon beauty is found in various parts. The manufactures are few and unimportant. The chief are silk, woollen and linen stuffs, glass, porcelain, paper, and jewellery. The fisheries are prosecuted along the coasts. The chief exports are wine, oil, silk, wool, honey, straw hats, sulphur, cattle, fruit, vegetables; imports, corn, cotton goods, hardware, machinery, etc. Value of exports (1880), £45,240,000; imports, £48,992,000. Trade is chiefly carried on with France, England, and Austria. Length of railways in operation, 5,147 miles. The established religion is the Roman Catholic, but other sects are tolerated. Education is in a very backward state, but music, poetry, sculpture, and painting are cultivated with success.

Formerly Italy comprised the various states of Sardinia, the two Sicilies, the Pontifical States, the Lombardo-Venetian provinces of Austria, the grand duchy of Tuscany, the duchies of Parma and Modena, and the republic of San Marino. These have all been united into one kingdom, under the king of Sardinia, now king of Italy. The executive power is vested in the king, the legislative in the king and the two houses of parliament—the Senate and the Chamber of Deputies,—the members of the latter being elected by the people. The effective army numbers 736,502 men, in addition to which the territorial and active militia number 979,293 men. The fleet consists of 69 vessels with 478 guns, and 15,055 officers and men. The estimated revenue for 1881 was £57,380,894; expenditure £57,068,479; and interest on national debt £19,747,890.



XLIII.

The Syntax of the Verb.

Oratio Directa and Oratio Obliqua.

When a speech is reported in the very words in which it was uttered by the speaker, it is called *oratio directa*—as in *Ita dicit, Ego vos amo*, thus he speaks, I love you. Here the words *ego vos amo* are in *oratio directa*, because they are the very words uttered by the speaker.

But when a speech is reported not in the exact words in which it was spoken, but so as to make the speaker the third person instead of the first, it is called *oratio obliqua*, or indirect speech—as *dicit se vos amare*, he says that he loves you. Here *se vos amare* are in *oratio obliqua*, as they give us not the exact words of the speaker, but the reporter's impression of them.

You cannot do better than commit to memory the following rules for *oratio obliqua*, taken from Roby's excellent "Philosophical Latin Grammar":—

I. All statements in principal sentences in the indicative mood in the *oratio recta* become infinitives in the *oratio obliqua*.

II. Those relative sentences in which *qui* = *et is* or *nam is*, *quum* = *et tum*, etc., have their verbs in the infinitive. Other relative sentences have their verbs in the subjunctive.

III. Questions in the indicative in the *oratio recta* are, if *closely* dependent on a verb of asking, put in the subjunctive; but, *if not*, in the infinitive, if of the first or third person; in the subjunctive, if of the second person:

e.g.—*quid facio* becomes *quid (se) facere.*
quid facis „ *quid (ille) faceret.*
quid facis „ *quid (illum) facere.*

But, if these questions *closely* follow a verb of asking, or inquiry, or informing, the verbs will all three stand in the subjunctive—as, *Rogavit quid (ipse, ille*, etc.) *faceret*, for all three alike.

IV. All subordinate sentences, as also all sentences in the subjunctive or imperative in the *oratio recta*, are put in the subjunctive in the *oratio obliqua*, with few exceptions.

V. When an indicative mood is found in the midst of the *oratio obliqua*, it expresses an assertion of the *narrator*, not of the person whose speech is being reported.

Now, there are two kinds of sentences which may be converted from direct to indirect or oblique narration—first, unconditional sentences, secondly, conditional sentences; and this may be effected in the manner represented on the opposite page.

Exercises.

Translate into English the following passages from Latin authors:—

Cæsar legatis respondit, diem se ad deliberandum scripturum esse. Ariovistus ad Cæsarem legatos mittit se velle de his rebus agere cum eo. Quis potest esse tam aversus a vero, qui neget hæc omnia, quæ videmus, deorum immortalium potestate administrari. Ariovistus respondit amicitiam Populi Romani sibi ornamento et præsidio, non detrimento, esse oportere; idque se eâ spe petîsse. Si per Populum Romanum stipendium remittatur et deditîtii subtrahantur, non minùs libentèr sese recusaturum Populi Romani amicitiam quàm appetierit. Quòd multitudinem Germanorum in Galliam transducat, id se sui muniendi, non Galliæ impugnandæ causâ facere; ejus rei testimonium esse, quòd nisi rogatus non venerit, et quòd bellum non intulerit, sed defenderit. Se priùs in Galliam venisse, quàm Populum Romanum. Ambiorix dixit habere nunc se rationem officii pro beneficiis Cæsaris; monere, orare Titurium pro hospitio, ut suæ ac militum saluti consulat; magnam manum Germanorum conductam Rhenum transîsse: hanc adfore biduo. "Si veteris contumeliæ oblivisci vellet, nam etiam recentium injuriarum deponere

posse?" Hæc quum animadvertisset, convocato consilio omniumque ordinum ad id consilium adhibitis centurionibus, vehementèr eos incusavit: primùm, quòd aut quam in partem, aut quo concilio ducerentur, sibi quærendum aut cogitandum putarent. Ariovistum se consule cupidissimè Populi Romani amicitiam appetisse: cur hunc tam temerè quisquam àb officio discessurum judicaret? Sibi quidèm persuaderi, cognitis suis postulatis

a *soothsayer* (*aruspex*). Aristotle says that certain animals are born which live one day only. It is announced to Cæsar that the Campanians are willing to do what he wished. The soldiers announce to Cæsar that they are prepared to open the gates of Corfinium, and to do what he commanded. The general sent word to the consul (saying) that he wished to confer with him on certain matters as quickly as possible. Indignation aroused the commons

UNCONDITIONAL SENTENCES.

ORATIO RECTA.	OBLIQUA ORATIO PRESENT.	OBLIQUA ORATIO PAST.
1. *I am come, because you ask,* Venio, quia rogas.	Ait se, quia ille rogat venire.	Dixit se, quia ille rogaret, venire.
2. *I came because you asked,* Veni, quia rogavisti.	Ait se, quia ille rogaverit, venisse.	Dixit se, quia ille rogavisset, venisse.
3. *I do not prevent you from going,* Non prohibeo quin eas.	Ait se, quin ille eat, non prohibere.	Dixit se, quin ille iret, non prohibere.
4. *Unless you do this you will be punished,* Nisi hoc agis *or* ages. punire.	Ait illum, nisi hoc agat, punitum iri.	Dixit, nisi ille hoc ageret, fore ut puniretur.
5. *May I die if I do not rejoice,* Moriar nisi gaudeo.	Ait velle se mori, nisi gaudeat.	Dixit, velle se mori nisi gauderet.
6. *You may ask what I am doing,* Roges quid faciam.	Rogare illum posse, quia ipse faciat.	Rogare illum posse quid ipse faceret.

CONDITIONAL SENTENCES, CONVERTED INTO ORATIO OBLIQUA.

ORATIO DIRECTA.	ORATIO OBLIQUA.
1. Aio te, si peccas, doles, *I say, "If you sin, you grieve."*	Aio te, si pecces, dolere, *I say that you grieve if you sin.*
2. Aio te, si peccabis, dolebis, *I say, "If you will sin, you will grieve."*	Aio te, si pecces, doliturum esse, *I say you will grieve if you sin.*
3. Aio "si peccaveris, dolueris." *I say, "If you shall have sinned, you will have grieved."*	Aio te, si peccaveris, doliturum esse. *I say you will grieve if you have sinned.*
4. Aio "si pecces, doleas," *I say, "If you may sin, you may grieve."*	Aio te, si peccaturus sis, doliturum esse, *I say you will grieve if you happen to sin.*
5. Aio "si peccares, doleres," *I say, "If you should sin, you would grieve."*	Aio te si peccares doliturum esse, *I say you will grieve if you should sin.*
6. Aiebam "si peccavisses, doluisses," *I did say, "If you had sinned, you would have grieved."*	Aio te si peccavisses doliturum fuisse,
7. Aiebam "si peccares, doluisses," *I did say, "If you would sin, you would grieve."*	Aio te si peccares doliturum fore.
8. Aiebam "si peccavisses dolores," *I did say, that had you sinned you would grieve.*	Aio te si peccavisses, doliturum fore.

atque æquitate conditionum perspecta, eum neque suam neque Populi Romani gratiam repudiaturum. Quòd si furore atque amentia impulsus bellum intulisset, quid tandem vererentur? aut cur de sua virtute aut de ipsius diligentia desperarent?

Translate into Latin:—

Cato used to say that he wondered that a soothsayer did not laugh when he had seen

(saying), "They were now attacked like open enemies, they were robbed of their bread and their living." All the tribune of the commons were furious (they asked), "What did that mean? Could anything be more arrogant?" He asked the crowd, "When could they venture to demand redress against them?" Cicero made answer, "If they wish to lay down their arms, they can use him as their coadjutor, and send ambassadors to Cæsar." "If, however, he

should be bent on prosecuting the war against them, (he bade him) remember the original prowess of the Helvetii. Ariovistus made answer to the embassy "that if he had wanted anything of Cæsar he would have come to him." I say that if you do this, you gain much. I say that if you had done this you would have gained much. But some one may say "Virtue is to be commended." He said he came because you asked him. He said that he would be punished, unless he did this thing. He asked him what he was doing, and why. Themistocles informed Xerxes that steps *were being taken* (*id agi*) that the bridge should be destroyed which he had constructed over the Hellespont. Regulus declined to give an opinion, (contending that) while he was pledged on oath to an enemy he was no longer a senator of Rome. In doing a kindness we must consider upon what occasion, to what persons, in what manner, and for what reasons we should give our gifts. Let me know how long and why you intend staying at Rome. When you set sail for Greece, may the skies be clear and the winds favourable.

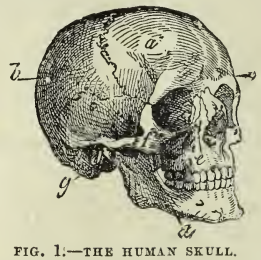


FIG. 1.—THE HUMAN SKULL.
a, frontal bone; *b*, parietal; *c*, temporal; *d*, inferior maxillary, or lower jawbone *e*, superior maxillary bone; *f*, molar bone; *g*, mastoid process of temporal bone.

Self-Examination Questions.

What are the points of difference between the *oratio directa* and *oratio obliqua?* Give the five general rules to be observed in turning *oratio directa* into *oratio obliqua*, and examples of each. Give also the special rules for converting conditional and unconditional sentences into *oratio obliqua*, and give an example of each. When an indicative mood is found in the midst of the *oratio obliqua*, does it express an assertion of the person whose speech is being reported? If not, what does it express?

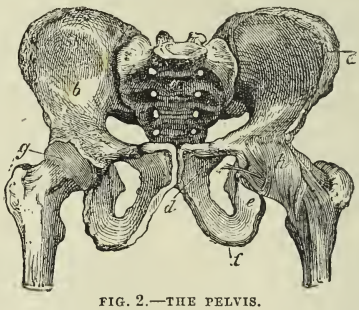


FIG. 2.—THE PELVIS.
a, sacrum; *b*, iliac fossa; *c*, crest of the ilium; *d*, os pubis; *e*, ischium; *f*, tuberosity of the ischium; *g*, head of femur; *h*, capsular ligament of hip joint.

By G. T. BETTANY M.A., B.Sc.

I.

INTRODUCTORY.

THE human body, both in its structure and the effects it produces, resembles a very complicated machine. Food is supplied to it, just as fuel is employed to generate motive power for mechanical work; but the body is especially distinguished by the fact that its motive power is generated at every spot where work is to be done. This indicates at once that the bodily machinery must be very complex in structure.

The body a complex machine.

Moreover, the work done by the organism is subdivided into a greater number of kinds than in any machine; this must increase the number of separate parts. All, however, are under a central government, with subordinate local governments; these have definite communications with the other structures to the minutest degree.

Subdivision of parts.

CLASSIFICATION OF STRUCTURES.

The parts of the body may be classified as follows:—

1. Hard structures, forming the framework of the organism, and protecting vital parts. Example, *bones.*

2. Parts fastened to these, to move the body entirely or partially, relatively to external objects or to other portions of itself; including means of offence and defence, the procuring of food, etc. Example, *muscles.*

3. Organs for chewing and swallowing solid and liquid food, and transforming it into the shape in which it can be used as bodily fuel, and the useless parts got rid of. Examples, *mouth, stomach, liver, intestine.*

4. Organs for perfecting and distributing the prepared fuel, and collecting the products of burning. Examples, *heart, blood-vessels, lymphatics.*

5. Organs for taking in gaseous food and getting rid of gaseous waste. Example, *lungs.*

6. Organs for removing waste materials in a liquid form, or such as can be dissolved in them. Examples, *kidneys, bladder.*

7. Organs for receiving impressions from outside the body. Examples, *eyes, nose, ears, tongue, skin.*

8. Seats of central and local government. Examples, *brain, spinal cord, nerve ganglia.*

9. Means of communicating impressions from organs of sense (7), and from internal parts of body, to central organs (8); also means of distributing to every part orders to do work. Example, *nerves.*

10. Organs of reproduction.

METHODS OF STUDY.

There is no way of acquiring a knowledge of human anatomy which is at all comparable to dissection of the body soon after death. The injection and distribution of a preservative solution throughout the body by means of the veins enables

Dissection.

the anatomist to preserve it for as long as is needful without decay. The parts are thus seen as nearly as possible in their natural condition. By the careful use of the knife and forceps, the structures, which are so beautifully packed together, are separated from one another, and their relative positions are accurately ascertained. In the case of mechanical actions, such as those of the muscles, by imitating the conditions during life, a notion is gained of the way in which they bring about the actions which are due to them. The size and the shape of each organ are seen, and the origin, course, and branching of nerves and bloodvessels are traced out. It is this knowledge which enables the skilful medical man to have literally an insight into the bodily frame. Finding that there is comparatively little variation in different cases, and thus knowing the normal or usual structure of every part, he can judge what part is affected in a diseased person, and can estimate changes of size and structure by various signs and symptoms. The surgeon knows how to avoid vital parts, and understands the necessary limits to his curative endeavours.

Similarity of structure.

But there are others besides those preparing for medical practice who feel the need of some knowledge of human anatomy as a part of their education, and an important element in learning how to preserve their health. To the majority, the actual dissection of the human body is inaccessible or repulsive, and they ask in what way they can practically learn what they desire.

Anatomy for those who are not doctors.

There is no doubt that actual dissection of a very valuable kind is open to them. The members of the great mammalian family—those animals which suckle their young—are so very much alike in structure, that, except for purely professional purposes, the dissection of one illustrates all; and the examination of any quadruped will give more real instruction about human anatomy than a great deal of book-reading without it. If our readers will take the trouble to dissect a rabbit, and compare what they see with what is stated in the following chapters, they will be placed in an excellent position for understanding Human Physiology.

Dissection of quadrupeds.

Human skeletons, dried and prepared, are also excellent helps, if they can be procured. The bones serve as capital aids to comprehending the bodily mechanism, and we learn much more easily by being able to associate the description of soft parts with the look of the bones near which they are situated. Those who have access to museums containing wax models, or preparations preserved in alcohol (or spirits of wine), will find them first-class helps in study; but it must always be borne in mind that anything thus seen is in a very different condition from its living active state.

Skeletons and models.

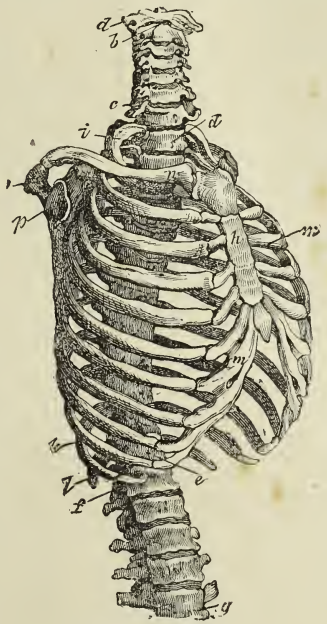


FIG. 3.—THE TRUNK.

a, the atlas vertebra; *b*, the axis vertebra; *c*, the seventh and last cervical vertebra; *d*, the first dorsal vertebra; *e*, the last dorsal vertebra; *f*, the first lumbar vertebra; *g*, the last lumbar vertebra; *h*, the sternum, or breast-bone; *i*, the first rib; *k*, the eleventh rib; *l*, the twelfth, or last rib; *m*, the costal cartilages; *n*, the clavicle, or collar bone; *o*, the acromion process of the scapula; *p*, the glenoid cavity of the scapula, for articulation with the head of the humerus.

Much that is requisite for any thorough comprehension of human life can only be learned by microscopical examination of the tissues. If suitable specimens are obtainable, they should be most carefully inspected and compared with the verbal descriptions given of them. These preparations form the basis of much that will be said under the head of Physiology. The same advantages, however, that attend the dissection of mammalian animals, are to be derived also from microscopical research into their tissues, and can be attained by any one who has time, perseverance, and a microscope. Furthermore, any real knowledge of animal structure derived from observation will be a benefit to the tyro in human anatomy.

Microscopic study.

Lastly, there is no doubt that life can be best studied in a living creature, if that creature admits of convenient examination and any kind of analysis of the particular thing studied. Thus it is most necessary to insist on what can be ascertained by any one by examining his own or his friend's body; and when this has been acquired, much more can be pointed out, by those who have a deeper knowledge, concerning the outside indications that may be observed of internal arrangements. This knowledge can be easily acquired by every one, and is therefore dealt with at some length.

Anatomy studied in the living subject.

The Parts of the Body.

Our common language provides us with most useful indications of the general structure of the body. *Head*, *trunk*, and *limbs*, are terms universally understood. The head is for external perception, by

General build.

the special senses whose organs are located in it, and for internal reflection and exercise of the will. The trunk, often usurping the title "body," which properly belongs to the whole organism, contains the vital organs for breathing and digesting. The limbs are the means of movement from place to place, or *locomotion;* instruments for taking food, *prehension;* weapons for offence and defence, and also weapon-holders. Furthermore, the limbs are the agents by which man works out his "many inventions" which he has so carefully sought out, and the instruments of *manipulation*, by which the arts of life are carried on, by means of which the eye and the ear and the brain attain their desired satisfaction. The limbs are continued directly from the trunk, while the head is set upon the latter by means of a flexible *neck*.

Head.

Trunk.

Limbs: for locomotion, prehension, offence, manipulation.

The trunk has four principal angles or corners, and from each of these a limb is extended. The limbs are longer than the trunk, but of much less girth, and of a more or less rounded outline, while the trunk is flattened from before backwards. We see by their form and position that the limbs are in pairs—the upper extremities, or arms, and the lower extremities, or legs.

Limbs in pairs.

Very slight observation shows that each limb consists of several parts more or less distinct from one another; and that at their free ends they are divided into five parts, or *digits*, which can move separately from one another. Like the limbs, the digits themselves possess several parts movable upon each other.

Corresponding divisions.

The upper limbs naturally hang downwards at the side of the trunk. Their first division is the upper *arm*, or arm proper; the next is the *forearm*; joined to this by the *wrist* is the hand, with its broad undivided region, the *palm*, and the digits or *fingers*.

Parts of arm.

The lower limbs are directly beneath the trunk when the body is erect. The upper and longer portion is the thigh; beneath this is the leg proper, with its shin and calf; and below it, at right angles, the foot extends for several inches forwards, the whole body being supported by the two feet. The *heel* is the back part of the foot; the *sole* is the principal region beneath; and in front are the digits, called *toes*, much shorter than the fingers.

Parts of leg.

Nature of the Principal Structures.

We may now explain a little more fully the nature of the principal groups of structures we find in the body. Beginning with the bones (1, p. 528), they are hard masses which support and give attachment to the soft parts, and maintain the form of the entire organism. The principal part of their bulk is composed of earthy salts, especially salts of lime; but they are permeated by bloodvessels, and the salts of lime are deposited in living animal substance. Thus they afford material to pull from or to push against.

Bones, hard, earthy, and vascular.

A skeleton in one piece would be comparatively useless to us; it might surround and protect other organs, but it would not give much aid to motion or any great means of offence. But if a skeleton is in several pieces, the parts can be moved towards or away from one another, and any outside object can be touched or struck by their motion. In order to enable this to be done perfectly, the bones in our skeleton are brought close together, and tipped with a smooth, hard, dense substance called *cartilage*, or gristle. This contains but a slight proportion of earthy salts, and consists chiefly of very condensed animal matter.

Skeleton of many pieces.

Cartilage.

The smooth surfaces of the ends of the bones are shaped so as to work suitably together, and frequently the round "head" of one bone fits into a more or less cup-shaped cavity in another. The ends of adjacent bones are kept in position and yet allowed to move easily, being loosely enclosed by bands of fibres called *ligaments*, attached to both bones. Thus a *joint* is formed, being really a loose bag preventing the bones from getting out of place, and containing the smooth surfaces by which they work upon one another.

Smooth ends, adapted to one another.

Ligaments connecting.

Joints.

Thus we have a system of excellent levers provided; the *muscles* supply the power by which the levers are worked. A muscle is essentially a mass of very active living substance, which is capable, under certain circumstances, or *stimuli*, of shortening in one direction and correspondingly thickening in another. All muscles are composed of fibres which are much longer than broad, and their function is to become shorter and thicker when required, so that the two ends come closer together. If the muscle is attached at its extremities to bones which can move, the bones will be brought nearer to one another.

Muscles, motor power.

Mechanical work by contraction of fibres.

Muscles consist of bundles of muscle-fibres, with nerves and bloodvessels intermixed. They have definite shapes and sizes, according to the work they have to do and the directions in which they act. Our motion from place to place is accomplished by various combined actions of many distinct muscles packed together in the limbs and trunk. It is the same with the actions by which we change the shape of the body while as a whole it is at rest, those by which we take food, etc.

Complex working by combination.

All muscles are not fixed to bones; some are merely attached to parts of the skin, and when they contract, draw it up into wrinkles. Others are found around the walls of tubes or bags, disposed in a circular fashion, so that when they contract they diminish the internal cavity which they surround.

Skin and tube muscles.

XXXVI.

THE VERB (*continued*).

Practical Application (continued).

V. Model of a verb in *yer*, conjugated interrogatively and negatively in those tenses where the sense allows it:—

INFINITIVE.

Present—ployer, *to bend.*
Past—avoir ployé, *to have bent.*

PARTICIPLES.

Present—ployant, *bending.*
Past—ployé, *bent;* ayant ployé, *having bent.*

INDICATIVE.

Present.	*Perfect Indefinite.*
est-ce que je ne ploie pas?	est-ce que je n'ai pas ployé?
or ne ployé-je pas?	*or* n'ai-je pas ployé?
do I not bend? etc.	*have I not bent?*
ne ploies-tu pas?	n'as-tu pas ployé?
ne ploie-t-il pas?	n'a-t-il pas ployé?
ne ployons-nous pas?	n'avons-nous pas ployé?
ne ployez-vous pas?	n'avez-vous pas ployé?
ne ploient-ils pas?	n'ont-ils pas ployé?
Imperfect.	*Pluperfect.*
ne ployais-je pas?	n'avais-je pas ployé?
was I not bending?	*had I not bent?*
ne ployais-tu pas?	n'avais-tu pas ployé?
ne ployait-il pas?	n'avait-il ,, ,,
ne ployions-nous pas?	n'avions-nous pas ployé?
ne ployiez-vous pas?	n'aviez-vous ,, ,,
ne ployaient-ils pas?	n'avaient-ils ,, ,,
Perfect Definite.	*Perfect Anterior.*
ne ployai-je pas?	n'eus-je pas ployé?
did I not bend?	*had I not bent?*
ne ployas-tu pas?	n'eus-tu pas ployé?
ne ploya-t-il pas?	n'eut-il ,, ,,
ne ployâmes-nous pas?	n'eûmes-nous pas ployé?
ne ployâtes-vous pas?	n'eûtes-vous ,, ,,
ne ployèrent-ils pas?	n'eurent-ils ,, ,,
Future Absolute.	*Future Anterior.*
ne ploierai-je pas?	n'aurai-je pas ployé?
shall I not bend?	*shall I not have bent?*
ne ploieras-tu pas?	n'auras-tu pas ployé?
ne ploiera-t-il pas?	n'aura-t-il ,, ,,
ne ploierons-nous pas?	n'aurons-nous pas ployé?
ne ploierez-vous pas?	n'aurez-vous ,, ,,
ne ploieront-ils pas?	n'auront-ils ,, ,,

CONDITIONAL.

Present or *Future.*	*Past.*
ne ploierais-je pas?	ne l'aurais-je pas ployé?[1]
should I not bend?	*should I not have bent him?*
ne ploierais-tu pas?	ne l'aurais-tu pas ployée?[2]
ne ploierait-il pas?	ne les aurait-il pas ployés?[3]
ne ploierions-nous pas?	ne les aurions-nous pas ployées?[4]
ne ploieriez-vous pas?	n'en auriez-vous pas ployé?[5] [ployé?[5]
ne ploieraient-ils pas?	ne leur auraient-ils pas

[1] Because *l'* stands for *le*, m.s. [2] *l'* stands for *la*, f.s. [3] *les* stands for a m.p. [4] *les* stands for a f.p. [5] because *en* and *y* are indirect objects. See *remark* upon *placer* (p. 511).

IMPERATIVE.

Affirmative.	*Negative.*
ploie-le,	ne le ploie pas,
bend him.	*do not bend him*, or *it.*
qu'il la ploie,	qu'il ne la ploie pas,
let him bend her.	*let him not bend her.*
ployons-les,	ne les ployons pas,
let us bend them.	*let us not bend them.*
ployez-en,	n'en ployez pas,
bend ye some.	*do not bend any.*
qu'ils se ploient,	qu'ils ne se ploient pas,
let them bend themselves.	*let them not bend themselves.*

SUBJUNCTIVE.

Present.	*Perfect Definite.*
que je ploie,	que j'aie ployé,
que tu ploies,	que tu aies ployé,
qu'il ploie,	qu'il ait ployé,
que nous ployions,	que nous ayons ployé,
que vous ployiez,	que vous ayez ,,
qu'ils ploient,	qu'ils aient ,,
That I may bend.	*That I may have bent.*
Imperfect.	*Pluperfect.*
que je ployasse,	que j'eusse ployé,
that I might bend.	*that I might have bent.*
que tu ployasses,	que tu eusses ployé,
qu'il ployât,	qu'il eût ployé,
que nous ployassions,	que nous eussions ployé,
que vous ployassiez,	que vous eussiez ,,
qu'ils ployassent.	qu'ils eussent ,,

VI. Conjugate after *manger:*

déloger, *to decamp*	plonger, *to plunge*
déranger, *to disturb*	songer, *to think*
engager, *to induce*	soulager, *to relieve*
patauger, *to make a nice mess of it*	vendanger, *to cut the grapes, do the vintage*

Conjugate after *placer:*

balancer, *to waver*	menacer, *to threaten*
commencer, *to begin*	pincer, *to pinch*
forcer, *to force*	sucer, *to suck*
lancer, *to dart*	tancer, *to scold*

Conjugate like *employer:*

balayer, *to sweep*	ennuyer, *to weary*
broyer, *to crush*	essuyer, *to wipe*
coudoyer, *to jostle*	grasseyer, *to burr*
employer, *to employ*	noyer, *to drown*

Conjugate like *nier:*

crier, *to cry*	plier, *to fold*
délier, *to loosen*	relier, *to bind*
lier, *to tie*	renier, *to renounce, deny*
pépier, *to chirp*	supplier, *to entreat*

Conjugate like *créer:*

recréer, *to create again*	gréer, *to rig*
récréer, *to refresh*	agréer, *to accept*
procréer, *to beget*	désagréer, *to disagree*
suppléer, *to make up for*	ragréer, *to finish*

EXERCISE XLVI.

1. The bee, the grasshopper, the cricket—everything hums and chirps in (*en*) summer (p. 47). 2. The cuckoo was crying in (*au*) spring; *I wish the cuckoo would cry* (would wish = *voudrais*, that the c. might cry). 3. The cockchafer, as well as the bee, the fly, and the humming-bird, hums. 4. Owls (3, p. 3, V. I.) screech or hoot; I wish the owl would hoot. 5. The ravens were croaking in the trees (*dans les arbres*), and the frogs were croaking in the pond (*étang*). 6. The lark carols, the jay chatters, the blackbird whistles, the chaffinch warbles, [2]the nightingale [1]alone (*seul*) sings. 7. *To* say (*dire*) that the blackbirds, the serpent and the goose *whistle*, betrays (*trahir*, p. 7) a certain poverty of language (*une certaine pauvreté de la langue*). 8. Crocodiles (3, p. 3, V. I.) eat flesh (*chair*, f.) and fish (*poisson*, m.); elephants eat grass (*herbe*, h.m.). 9. The storks will begin to build (*à bâtir*) in (*dans*) *about* a fortnight; will they eat all (*toutes*) the frogs? *they will* (*say* they will eat them). 10. The sparrow chirps even in (*même en*) winter. 11. We disturb them; we were thinking *of it* (to it); we plunged our sticks (*bâtons*) into it; we shall relieve you; we should make-a-nice-mess-of-it. 12. I wish (*see* 2, above) he would induce them to (*à*) decamp. 13. You will begin to cut your grapes *on* Tuesday next

(*prochain*); I wish *you to* (*veux*, that you may) eut grapes on Monday next. 14. He threatens her; he was placing them; he scolded him roundly (*vertement*); he will dart it. 15. We do not force you; we were not pinching him; do not suck your thumb, pray (donc pas votre pouce). 16. I employ some; thou drownest some; he does not crush any; she folds more (of them) than you. 17. That we may wipe them; that you may not weary us; they were sweeping; how that man burrs (*comme cet*)! how that woman jostles one (*le monde*)! 18. We were not folding them, we were tying them; I do not say (*dis*) that you are entreating, but that you were entreating. 19. He loosens it; he was not binding it; did he not deny (*renounce*) him? 20. He rigs a brig (*un brick*); we rig our bark (*barque*, f.); accept the expression (*do.*) of my regrets (*do.*).

XVII.

VOLTAIC ELECTRICITY (*continued*).

THE electrolysis of iodide of potassium, mentioned in our last paper, brings us to a consideration of the electrolysis of those compounds which the chemist terms "salts." Without going into the exact details of the meaning which the chemist attaches to this term, we may say that a salt is a compound in which a metal is always present, usually in combination with an acid.

Electrolysis of salts.

These salts may be decomposed by the electric current when brought to a state of fusion by heat, or when existing in a state of solution. For their electrolysis in the latter condition, which is by far the more convenient one, the voltameter mentioned on p. 497 may be employed, or instead a piece of strong glass tubing bent into the form of the letter V, and supplied with platinum electrodes, may be used. This latter simple piece of apparatus is represented in fig. 58.

The decomposition of a solution of common salt, which consists of the metal sodium and the gas chlorine combined together in equivalent proportions, forms a very interesting experiment, as not only the salt, but the water also, is decomposed by the passage of the current.

Decomposition of common salt.

To make the experiment effective, the solution should be coloured blue with indigo or litmus. If this be done, chlorine being a very powerful bleaching agent, its liberation will be marked by the disappearance of the colour of the solution.

As soon as a current is sent through the solution, the oxygen of the water and the chlorine of the salt appear at the positive electrode, while the hydrogen of the water in company with the sodium of the salt are liberated at the negative electrode.

Another experiment in electrolysis, which is rendered more effective by colouring the water with litmus or some other vegetable blue, is the decomposition of sulphate of soda. This salt is formed by the action of sulphuric acid upon soda, and when an electric current is made to pass through it in solution, the connection between the soda and the acid is severed, the former being attracted to the kathode, the latter to the anode. It being one of the special properties of an acid to turn blue vegetable colouring-matters red, the presence of the sulphuric acid will be marked by the reddening of the solution.

Electrolysis of sulphate of soda.

Some of the most beautiful experiments which can possibly be performed are those connected with the electrolysis of the salts of silver and lead, of which the nitrate of silver and the acetate of lead afford the best examples. In these experiments crystals of silver or lead appear upon the negative electrode; and if the decomposition be effected in a glass cell, the image of which is, in a darkened room, focussed upon a screen, the experiment forms a most effective and beautiful lecture illustration. By reversing the direction of the current through the cell, the crystals may be seen at once to appear at the opposite electrode, and to dissolve off from the one at which they were first seen.

Electrolysis of silver and lead salts.

The discovery of the electrolysis of metallic salts soon developed into commercial importance, and led to the now well-known process of electro-plating—which simply consists of the decomposition by the electric current of some compound of the metals, gold, silver, copper, etc., and the consequent deposition upon materials placed in the solution of the particular metal with which the articles are required to be coated.

It would be, of course, beyond the purpose of these papers on electricity to go into the details of such a special subject as that of electro-plating, which has long since been raised to the condition of a fine art; it must therefore suffice to give a general idea of the manner in which the process is carried out in the coating of the baser metals with silver.

Electro-plating.

Fig. 59 represents a simple form of apparatus by which this process may be effected. A is a jar containing a solution composed of 100 parts by weight of water, 10 parts of cyanide or ferrocyanide of potassium, and 1 part of cyanide of silver. Across the top of this jar is placed a metal rod, B, and from this rod the article (we will suppose a spoon) to be coated is suspended by a metal wire, coated with wax except where it is attached to the spoon. C is another metal rod, from which is suspended by a silver wire a silver plate, D. The rod B is in connection with the zinc plate and the rod C with the copper plate of a Daniell's cell. The article to be plated must, before its immersion in the solution, be very carefully cleaned, in order that any grease spots, etc., may be removed.

When the current passes, silver is deposited

upon the spoon, which is, as will be seen, the *negative electrode*, and the released cyanogen dissolves from the silver plate a quantity of that metal equal to the quantity deposited upon the spoon, and by this means the solution is kept at its original strength. In the course of from one to two days the process is complete.

Before concluding our notice of the interesting subject of electrolysis, we must not omit to notice the laws by which the process is governed, as discovered and formulated by Faraday himself.

Faraday's electrolytic laws.

It was early noticed by this distinguished investigator, that if the same current were sent through a succession of cells, containing different substances, the same weight of substance was not decomposed.

If, for instance, the current is sent successively through water, oxide of lead, chloride of lead, iodide of lead, and chloride of silver, the weights of these substances decomposed by the current are respectively 9, 111·5, 139, 230·5, 143·5. It will be found further, that in the first case the weight of oxygen will be to the weight of hydrogen produced in the proportion of 8 to 1; in the second case the proportion of oxygen released to that of the lead deposited will be as 8 to 103·5; in the third case the proportions between the chlorine and lead resulting from the decomposition will be 35·5 to 103·5; in the case of iodide of lead the proportions between the iodine and the metal will be as 127 to 103·5; while in the last case the proportion of chlorine liberated to the silver deposited will be as 35·5 to 108.

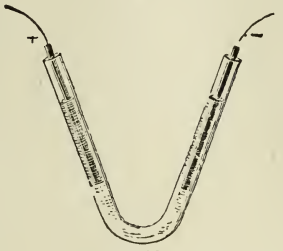


FIG. 58.

Now, these figures must evidently have a meaning, and the meaning is at once evident when we turn to a consideration of what are known as the atomic weights of the elements. The term "atomic weights" requires some explanation. As our readers probably know, or as they may easily learn from the articles upon Chemistry in this work, there are known to chemists about sixty-five simple substances, which are termed Elements. From these elements nothing simpler than themselves can be obtained, and from the endless ways in which these elements combine with each other result all the compounds known.

Atomic weights.

Now, it is found that of all these elements hydrogen is, bulk for bulk, the lightest, and is consequently selected as the standard element with which all the rest may, with respect to their specific weight, be compared; and *its* weight is therefore called 1. With this standard the other elements are compared, and the weight of a given volume of the vapour of each, as compared with the weight of an equal volume of hydrogen under the same conditions, is taken as their "atomic" weight. Compared in this way, oxygen is found to have an atomic weight of 16; chlorine of 35·5; and iodine, 127. Now, it is found that not only have these bodies the specific weights set down to them, but also they always combine with each other in these same definite proportions, or in multiples of these numbers. For instance, in a compound containing chlorine you may have 35·5 parts by weight, or 71 parts, or 106·5 parts of that element, but you will never get any proportion between these numbers existing. These numbers are consequently frequently spoken of as the *combining numbers* of the elements; but from considerations into which it is not our province here to enter, it is regarded as certain that they do actually represent the *atom weights* of the respective elements concerned.

The standard of comparison.

To return to the consideration of the electrolysis of the compounds mentioned above, we find that the weights of the elements resulting from their decomposition are in the exact proportion of their combining or atomic weights, or else in some proportion that is very simply related to these, as in the case of water, in which we have one atom of oxygen united to two atoms of hydrogen, the weights of these elements present in water being therefore respectively 16 and 2, which are of course in the proportion of 8 to 1, given above.

Proportionate weights of electrolyses.

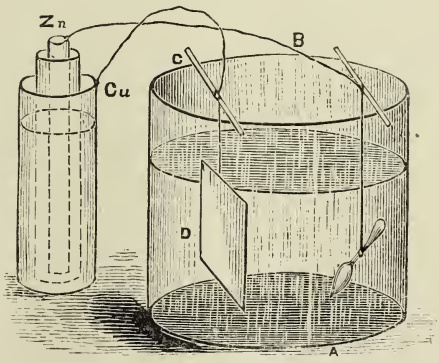


FIG. 59.

The first and fundamental law of electrolysis, as enunciated by Faraday, is therefore as follows:—

Laws of electrolysis.

The same quantity of electricity—that is, the same electric current—decomposes chemically equivalent quantities of all the bodies which it traverses; consequently, *the weights of the elements separated in these electrolyses are to each other as their chemical equivalents.*

To this Faraday appended many other laws, of which we have already sufficiently dwelt upon the two following:—

Electrolysis cannot take place unless the electrolyte is a conductor.

The energy of the electrolytic action of the current is the same in all its parts.

We have seen that when water is decomposed by the electric current oxygen is evolved at the positive and hydrogen at the negative electrode, and we know that therefore these gases are respectively *electro-negative* and *electro-positive*. From this knowledge it will easily be understood that when a current is sent through an electrolysis cell, the films of gas which cover the two electrodes are capable of acting towards each other as plates of different metals would; and that, in fact, a current may be set up in the cell, the oxygen playing the part of a copper plate and the hydrogen that of a zinc plate. This condition is known as the *polarisation* of the electrodes; and when this polarisation has been effected, upon disconnecting the battery from the electrolysis apparatus, a current passes through the water in the latter from the hydrogen to the oxygen. Such a current is termed a *polarisation current*. As we have already seen, a similar current may exist in the cells of the battery itself, tending to destroy the original current.

Electric polarisation.

If instead of employing a simple electrolysis cell several be used, joined together so as to form a battery, upon sending a current through this battery all the cells become charged with oxygen and hydrogen films, and upon uniting the terminals of this so-called *secondary* battery, a current of considerable intensity may be obtained.

A modification of the voltaic pile has been constructed upon this principle, and is known from the name of its inventor as *Ritter's secondary pile*. This consists merely of a series of plates of the same metal separated from each other by pieces of bibulous paper or cloth soaked in acidulated water. A current is then sent through the pile, and, like the battery just mentioned, it becomes polarised, each plate having a film of oxygen on one side and a film of hydrogen on the other.

Ritter's secondary pile.

Having now obtained some knowledge of the production and nature of electricity in its two forms of high-tension or frictional and low-tension or voltaic electricity, we have now to turn our attention to the connection between electricity and magnetism. The interesting and intimate relations that exist between these two forces were not brought to light in a complete way until Faraday worked at the subject—his discovery of magneto-electricity being the grandest labour that adorns his memory. Of the two forms of electricity mentioned above, it is the low-tension that yields itself the more readily in tracing the connection between electricity and magnetism, but we shall find in our subsequent study that this subject will lead us to the interesting topic of the relations existing between the two widely differing forms of electricity itself. But it will be first necessary to make ourselves acquainted with the most important phenomena of *natural* magnetism, and this subject will therefore occupy our attention for the next few chapters.

Connection between electricity and magnetism.

BY H. W. DULCKEN, Ph D.

I.

From the Earliest Times to the Death of Chaucer.

Origin of the English Language.

In placing before our readers in a compendious form the various periods of the literature of England, it is necessary in the first instance briefly to indicate the nature of the language in which that literature is contained, the sources from which the English sprang, and the changes it has undergone.

The present century has seen a great advance in our knowledge of the origin of the European languages, and of their affinities to each other; in fact, a new system of putting languages side by side, and observing their affinities, has been introduced; and this science has received the name of Comparative Philology. A number of great German names are associated with this interesting subject,—Bopp, Grimm, Diez, Ewald; but, more than by any other author, the subject has been popularized by the learned Dr. Max Müller, in whose *Lectures on the Science of Language*, and *Chips from a German Workshop*, the student will find a mine of curious and useful information.

Comparative Philology; a new study.

The labours of all these eminent men point to some very ancient language, now lost, as the parent of the great Aryan or Indo-European family of tongues, to which the languages of a great part of Europe belong. Two other ancient and lost sources of language existed: one, the original language of the Semitic race, from which are derived the Arabic, Hebrew, Syriac, and other Eastern tongues; the other, the Turanian, from which are derived the dialects of the wandering or nomadic tribes of central and northern Asia, known popularly as the Tartars, and more accurately as the Mongols, Samoyedes, Finns, Tungusi, and many others.

The great Indo-European stock is naturally divided into many branches; just as the trunk of a great tree, growing forth from the earth, separates at a certain distance above the surface into limbs, sturdy and thick, from which in turn spring forth the slender branches: so that in many cases the limb, if separated from the parent stem, would seem to form a tree of itself. Thus the great Aryan language-tree may be said to have six branches. The first is the Indo-Persian branch, to which belongs the Sanscrit, the ancient language of the Hindūs, whose discovery is called by Max Müller "a happy accident," which like an electric spark caused the floating elements to crystallize into regular forms,—the language which the Chinese pilgrims went to India to

The Aryan languages.

study, as the key to the sacred literature of Buddhism. The other great limbs of the language-tree are the Hellenic (Greek), Italic (Latin), Teutonic (German), Celtic or Kcltic, and Sclavonic languages.

At various periods, before the commencement of written history, there were great migrations of nations from the East towards the West. One of these migrations was that of the race called Celts or Kelts. They were Aryans, and settled in the western countries of Europe; where kingdoms were founded on the ruins of the Roman empire. They were a strong warlike race, and had threatened Rome already before the Christian era. Five consular armies had they destroyed in succession; and Ariovistus, the Teuton chief, had defied the great Julius Cæsar himself. "Let them come on if they wanted to fight," was the bold barbarian's defiance of the Romans; "they should learn what could be done in war by the unconquered Germans, who in seventeen years had not been under a roof."

Keltic or Celtic nations; Teutons and Sclavonians.

From these strong Teutons we derive the Germanic languages; the Dutch, German, Flemish, and Scandinavian languages all belonging to the same stock.

A third migration from the East into Europe produced the Sclavonic or Wendic languages, spoken in eastern Europe — the Russian, Bohemian, Polish, Lithuanian, Lettish, and many other dialects.

Languages have their periods of growth and development, and undergo many modifications and changes. Phrases that would be considered correct in one century would be pronounced faulty in another: for instance, Shakespeare's "Nothing neither way," "The most unkindest cut of all," "Those springs, on chaliced flowers that lics;" or Swift's "I had like to have got one or two broken heads," would not pass muster now that the rules of grammar and style are rigidly laid down. Words drop out of the language and become obsolete; others are taken into general use. A "kybe" for a bruise, "yclept" for called, a "patch" for a fool or a jester, would not now be understood. Even the pronunciation of words alters in the course of time. Pope, in the last century, made the word "obliged" to rhyme with "besieged," for it was pronounced "obleeged." Shakespeare wrote, "Now is it *Rome* indeed, and *room* enough;" thus Rome was evidently pronounced as *room* in his time; and in *The Taming of the Shrew* the word "shrew" is made to rhyme with *show* and *so*. And in the form of words great alterations also take place, the general tendency being towards the shortening of words, as we shall have to show further on. To understand the language and literature of a nation, we have first therefore to consider the sources whence the language was derived, the changes it underwent in the course of time, and the condition in which it is found to have been at various periods.

Progress of language.

The written history of our country begins with the invasion of Julius Cæsar, B.C. 44; and the first authentic sentence written concerning Britain is in that passage in Cæsar's Commentaries in which the great conqueror tells how, the proper season having arrived, he started from the coast of Gaul with his war-galleys, how the Britons rushed into the sea to oppose the landing of his soldiers, and how the standard-bearer of the famous tenth legion sprang from the ship into the water with the cry "Desilite, commilitones!"—"Jump down, fellow-soldiers! unless you wish to betray your eagle into the hands of the enemy." The language of the bold barbarians of these islands, the ancient British tongue, has entirely faded out of England. An old Cornishwoman of the eighteenth century is said to have been the last person who spoke the British language in this country. But in Wales, in the Scottish Highlands, in Ireland, and in the Isle of Man, under various names and in different dialects, the Celtic yet exists. A remarkable instance of the tenacity of life in ancient languages was exhibited about a hundred years since, at the siege of Belleisle in Brittany. There were in the English army many Welshmen; and they were astonished to find that they and the peasants of Brittany could understand each other. Twelve hundred years before, many Britons, driven into the corners of the island by the Saxons, had crossed the channel to Armorica, which was afterwards called from these settlers Bretagne; and the Cornwall Britons had given to a district of their new country the name of "Le Pays de Cornouaille." And here was the language spoken by the Bretons of the eighteenth century still identical with that of the descendants of the Britons left behind in Wales and south-western England.

The Britons and their language.

The Celtic language of the Britons has left but few traces in England; the chief are found in names of places —*aber* signifying the mouth of a river, *dun* a hill, as in "Aberdovey," "Dunbar," etc. There are other words of British origin, but they are few. In the same way the Romans left traces of their dominion in the names of places founded by them, the termination *caster* or *cester* signifying a fortified camp, as in "Silchester," "Lancaster," "Rochester," etc.

Traces of the Celtic element.

The Anglo-Saxon Period.

The beginning of the fifth century saw the Roman legions withdrawn from Britain; the middle of the century saw the landing of the advanced guard of the Saxons, that savage and uncultivated but sturdy and warlike race, who in the course of two centuries conquered the country,—not subjugating the inhabitants, as the Romans had subjected the Britons, but driving them before them as they themselves advanced, — until Wales, Cornwall, and lastly the opposite coast, became the refuge of the Britons. Till the middle of the eleventh century the Angles, Jutes, and Saxons held sway in what was now called England — their government being, however, interfered with by the Danes; and accordingly

The Saxons.

their Teutonic language was established everywhere, together with their government; and thus the Anglo-Saxon forms the basis of the English language. Those writers of modern times are considered the most national who have chosen words from the Anglo-Saxon rather than from Latin or French roots, and who have cultivated what is called "a good Saxon style."

The Anglo-Saxon language.

The Anglo-Saxon language advanced quickly, as the wild tribes by whom it was spoken became civilized, and especially as they came under the influence of the Christian Church. Canterbury, or *Kantwarabeorg* (the town of the men of Kent), became the seat of a community of learned Anglo-Saxon churchmen, who in later times did much to spread Christianity and civilization in the yet barbarous and heathen parts of Europe. Winifrid or Bonifacius, an Anglo-Saxon, preached Christianity to the heathen tribes in the vast forests of Mecklenburgh and Pomerania. Alcuin and Eginhard, the one the secretary, the other the son-in-law of Charlemagne, were both Anglo-Saxons; and long before a line of French, German, or Italian had been written, the Anglo-Saxons in England possessed not only a language vigorous, exact, and subject to definite grammatical rules, but also a varied and valuable literature.

Anglo-Saxon and German.

The Anglo-Saxon shows a very great resemblance to the modern German; and was an inflected language, like the ancient Latin and Greek—that is to say, the different positions or cases in which nouns and adjectives could occur in a sentence were marked by differences in the termination of the word. Thus *gód*, the adjective "good," made *gódes*, "of good," in the genitive masculine, *gódum*, "to good," for the dative case, and so on. A great many words were also compound, or made up of two or more words—as *reste-dæg*, the Sabbath, or day of rest; *leorning-cnihtas*, disciples (literally learning-servants); *Angel-cynne*, Angle-race. Just in the same way in the modern German we have *Hand-schuh* (hand-shoe), a glove; *Lieder-tafel* (song-table), a harmonic society; *Licht-stümpfchen* (light-stump), a candle-end. The verbs also were regularly conjugated: *Ic drífe, ic dráf, drifen*, I drive, I drove, driven—*Ic lufige, ic lufode, lufod*, I love, I loved, loved—for the present tense, the past tense, and the past participle.

INDIAN WOLF.

ZOOLOGY.

XVII.

THE DOG FAMILY (*continued*).

Care for young.

THE female dog is most indefatigable in the care and nurture of her young, and displays great affection for them, and pride in exhibiting the youngsters. She will often cherish other young creatures, and this is especially manifested in a very general tenderness towards human infants. The male dog rarely cares much for his offspring.

In addition to what may be called general or human qualities, such as we have thus far detailed, another side of dog-nature is presented by the special instincts inherited by whole

breeds of dogs, and distinguishing them clearly.

Special instincts. No doubt these are mainly varieties, due to savage man's necessity of procuring food by hunting; and it would appear that as many instincts have become developed as there are kinds of prey or circumstances of capture. The varieties once formed have been perpetuated and improved by human selection, by pure breeding, and by occasional crosses, such as that which so much improved the greyhound by crossing with a bull-dog.

Careful and select breeding.

The modern varieties are not permanent species; they soon degenerate if great care is not taken in their breeding.

We can say very little here about the varieties of dogs, beyond giving a general classification, based on faculties exhibited. We may subdivide them according as they are kept:

Chief varieties. (1) for their drawing power, of which the savage Esquimo dog is a good example; (2) for their speed; (3) for their scent; (4) for their destructive powers; (5) for watch dogs; (6) as pets.

THE BULL-DOG.

As we find in other creatures besides dogs, speed and intelligence do not always go together; and the greyhounds, which include some of the most beautiful animals imaginable, and the fleetest, have smaller brains, corresponding to their inferior intelligence and to their slender heads. The most slender and beautiful is the petted Italian greyhound. The dogs generally distinguished for acuteness of scent have a large proportionate size of brain.

Greyhounds.

The spaniels, notwithstanding the existence of degenerate forms of them, of very little use except to devour dainties at the hands of the idler members of society, are of much general interest. They include, in addition to dogs commonly known as spaniels and poodles, those magnificent types the Newfoundland, the sheep-dog, and the St. Bernard. To name these dogs is to recall a host of familiar associations of courage, ready wit, and humanity. Perhaps the old Newfoundland, who, seeing his master after many years' absence, recognised him with such joy that he died under the strain of his extreme emotion, claims our highest regard, in consequence of the long years during which he had retained his master's memory fresh in his heart. But one is at a loss to select from the tales of the noble perseverance of Newfoundland and St. Bernard dogs in rescuing from drowning or from freezing many a traveller, sailor, or little child. The Newfoundland is aided to a considerable extent in swimming by the webs which connect the toes. The sheep-dog has in many ways proved himself to be the worthy ally of these noble creatures; his ready wit disciplines the wandering sheep, and his care for his master's interests extends to his master's person. No creatures apparently understand human words and directions more thoroughly than some of the grand Scotch collies.

Spaniels.

Newfoundland.

St. Bernard.

Sheep-dog.

The hounds, under their various forms of beagle, harrier, foxhound, staghound, and bloodhound, are most highly developed for their particular work. Their speed — reaching sometimes to thirty miles an hour—and their scent are equally famous. The setter, crouching to indicate the position of game; the pointers, standing mute when they find their game; the retriever, specially valuable for sport on the marsh and river bank, being trained to fetch the wounded game without injuring it, are familiar in our mouths as household words.

Hounds and retrievers.

DINGO.

The British admiration of "pluck" in every shape accounts for the attention paid to the bull-dog, which, with the foxhound, may lay claim to being a typical English dog. The happily obsolete sport of bull-baiting, wherein the bull-dog never knew when he was beaten, gave this creature his name and his practice in hanging on to any antagonist with matchless pertinacity. Of course pugnacity of this kind does not go with amiability or beauty, and the bull-dog's evil eyes, flattened skull, and bent legs take away any pretence to handsome looks. The mastiff is a fine large handsome type, both interesting as having resemblances to the bull-dog and valuable as a house-guard. Rats would give a somewhat prejudiced but different account of the English terrier from their masters; while the distinct Scotch terrier is best known for his

Bull-dog.

Mastiff.

Terrier.

faithfulness and good disposition. Finally, we must now, with regret, leave the dogs by referring to the Australian and Tasmanian dog, the dingo, which was found wild when Europeans first visited Australasia. He is of a large type and of ferocious disposition. It is believed by many that the species was introduced from other lands before the arrival of Europeans.

Dingo.

The Wolf has an undeniably bad character. This is but natural, seeing what multitudes of man's domestic cattle and fowl he has destroyed. His bad taste in feeding on men and dogs if need be, his congregating in packs of invincible numbers and ferocity, and his horrible howl, combine to make him hated wherever he is abundant. Yet he has the merit of being open in his attacks; but he is so deadly in his methods, that one considers his cruelty and success far outweigh the absence in his tactics of that concealment which is so striking a characteristic of the cat family.

Wolves.

In size the wolf is about equal to a large dog; he has a very bold straightforward aspect, no bark, but a howl, and a longish bushy tail, down-turned between his legs. In winter the wolves gather in packs, which course rapidly over the snow, and can surpass horses in speed. One specially objectionable characteristic is that a wolf usually kills far more than he can eat.

Characters.

It seems surprising to us, in our quiet times, to find that near the close of the seventeenth century wolves still existed in some parts of Scotland, and even until the beginning of the last century were causing damage in Ireland. Such, however, is not the happy condition of France and a large part of the continent of Europe. They flourish where there are extended tracts of hilly forest country. Various kinds of wolves, more or less distinct, abound in Syria, India, North America, and Brazil.

Extinct in Britain.

Abundant elsewhere.

The Jackal, known as the lion's provider, is another abundant member of the dog genus, with a long slender face, living on offal and decaying meat of any kind, following and killing weak or wounded animals, hunting in packs, and obeying a captain. They are tamable, but their odour is very unpleasant. North and South Africa, Senegal, Asia Minor, Persia, India, and South America, are the principal regions where jackals make life hideous to the traveller by their impudence, especially at night.

Jackals.

The Fox is the especially hunted member of this family, marked by a narrow vertical pupil, a very slender snout, nearly vertical ears, and a bushy tail or "brush." Fleetness and cunning are the well-known properties of this marauder. He would soon cease to exist in this country were it not for careful preservation; but the fox-hunter might still find his game in nearly all the northern parts of the Old and New Worlds, and even in North Africa. The Arctic fox is a distinct species, extremely wary, silent while seeking food at night, and caught by the inhabitants of the frozen regions in clever ice-traps, for the sake of the fur.

Foxes.

Arctic fox.

The African fennec, whose body is less than a foot long, with large upright ears, is very fox-like, but feeds principally on dates, fruit, and eggs. A long-eared fox-like form, of South Africa, has six more grinders than the other dogs. The hyæna-dog, another South African type, has only four toes on each foot. These dogs hunt in considerable packs, and run down the swiftest and strongest antelopes; they also resemble the hyæna in their liking for carrion. They are curiously parti-coloured, chiefly black, white, and yellow.

The fennec.

Hyæna dog.

XLII.

Variable Stars.

When carefully examined, a considerable number of stars have been found to undergo slight variations in brightness, as if from time to time they were liable to some change which tended to periodically lessen their brilliancy. But in most cases these changes are very small in amount, and are somewhat irregular in their occurrence. In a considerable number of instances, however, these variations in brightness are very large in amount and very regular in their periods. The following are the principal of these stars which are visible to the naked eye.

Variable stars.

β *Persei.*—R. A. = 3^h 0^m. Dec. = + 40° 30′. Changes from 2·5 mag. to 4 mag. in 2·86 days. It is usually of the $2\frac{1}{2}$ mag., and after remaining so for $2\frac{1}{2}$ days, it falls to the 4th mag. in the short space of $4\frac{1}{2}$ hours, and remains so for 20^m, and then commences to regain its brilliancy; and $3\frac{1}{2}$ hours later is again of the $2\frac{1}{2}$ mag.

δ *Cephei.*—R. A. = 22^h 25^m. Dec. = + 57° 48′. Changes from 3·7 mag. to 4·8 mag. in 5·36 days.

η *Aquila.*—R. A. = 19^h 47^m. Dec. = + 0° 44′. Changes from 3·6 mag. to 4·7 mag. in 7·17 days.

β *Lyræ.*—R. A. = 18^h 46^m. Dec. = + 33° 13′. Changes from 3·5 mag. to 4·5 mag. in 12·91 days.

o *Ceti.*—R. A. = 2^h 13^m. Dec. = − 3° 31′. Changes from 2 mag. to 10 mag. in 3·30 days.

This star is *Mira* Ceti. At its maximum brilliancy it shines like a star of the 2nd mag., and then gradually decreases for some seventy-four days, until it is no longer visible to the naked eye, and continues to decrease in brightness till of only the 10th mag., or with less than one thousandth part of its former brightness. It remains invisible to the naked eye for over two hundred days, then it reappears, and in forty-three days has recovered its maximum brightness. Its brilliancy at its

maximum and its period are subject, however, to very considerable and irregular variations.

ν Hydræ.—R.A. = 13h 23m. Dec. = −22° 32′. Changes from 4 mag. to 10 mag. in 436 days.

η Argus.—R.A. = 10h 41m. Dec. = −58° 57′. Changes from 1 mag. to about 6 mag. in some seventy years.

Amongst the telescopic stars there is a very considerable number of variables, some being stars of the 7th or 8th mag., which fade either quite out of view or down to the 13th or 14th mag. It is a noteworthy fact that most of these stars are red in colour, quite a number being deep-red, or even crimson. These variables are commonly designated by the capital Roman letters, as R Leporis, R Leonis, T Scorpii, S Herculis, etc.

No sound explanation of the cause of these variations has as yet been devised. It has been supposed that in some cases they may be due to the periodical formation of enormous masses of sun spots. Our own sun must from this cause undergo slight variations in brilliancy. But this could only explain very small variations in brightness. For a fall of brightness of only one magnitude would necessitate at least three-fourths of the surface being supposed covered with sun spots—a most unlikely circumstance. Others have suggested the passing of one or more opaque bodies before the star, as a planet or a dense flight of meteors; this hypothesis might explain some of the known cases, but only a very few. For the present, however, we must await further information before any feasible theory can be advanced to account for these remarkable variations in the brightness of these stars.

Explanation of variations.

Temporary Stars.

Besides those stars which undergo known periodical variations in brightness, a number of instances are known where bright stars have suddenly made their appearance, and after shining brightly for some time, have gradually faded away, either quite out of sight, or until very faint. Some of the more remarkable cases have been already referred to (see page 406, vol. i.), the most famous being that observed in Cassiopeia, by Tycho Brahé, in 1572, when the new star shone brighter than Jupiter; and that observed in Ophiuchus, in 1604, which shone brighter than even Venus. Of late times a number of additional instances have been witnessed, though none approaching those just referred to. In 1848 Hind discovered such a star in Ophiuchus (R.A. = 16h 54m, Dec. 12° 36′); it shone at its maximum as a star of the 4th mag., but gradually faded away until only of the 11th mag. Another instance was in the case of T Coronæ (R.A. = 15h 54m, Dec. = + 26° 16′), which was discovered by Bermingham in May, 1866, as a 2nd mag. star, which soon faded away to about the 10th mag. The spectroscope showed that the probable cause of the outburst of light in this star was due to the incandescence of immense quantities of hydrogen gas. In November, 1876, Schmidt discovered a new star in Cygnus (R.A. = 21h 37m, Dec. = + 42° 16′). It shone at first like a star of the 3rd mag., but rapidly faded away to the 12th mag. It is most remarkable that this body now gives the spectrum of a mass of gas exactly analogous to the spectrum of a planetary nebula; and it has been supposed that we have here an instance of a sun being converted into a nebula through being rendered highly incandescent by some unknown cause.

New temporary stars.

The Stars.

It has long been known that many of the principal stars in the heavens possess actual motions of their own, independent of the apparent motion they all have in common, due to the slow change in the position of the earth's axis. The stars are not absolutely fixed in position, as was originally believed, but are very slowly moving in the heavens, and this slow motion is called their "*Proper Motion.*" By comparing the relative places of the stars as carefully determined from two series of observations separated by a long interval of time, it has been found possible to approximately determine the amount of this proper motion in the case of a considerable number of stars. As a rule this proper motion is a very small quantity, rarely more than a very small fraction of a second of arc in a year, but in some few cases it is much more, showing that some stars are very rapidly moving through space. And the consideration of these proper motions has already led to some very interesting speculations regarding the constitution of the universe. Thus it has been found that the average proper motion of the stars seems to decrease with their brightness, which is what might be anticipated were the average distance of the fainter stars greater than the average distance of the brighter ones. For instance, the average proper motion of the 48 stars of the second magnitude is nearly 2½ times as great as the average proper motion of the 313 stars of the fourth magnitude, just as might be anticipated from the consideration that the difference in brightness of the two classes of stars would lead to the conclusion that the average distance of a star of the fourth magnitude would be about 2½ times the distance of a star of the second magnitude.

Proper motions of stars.

Relation between proper motion and distance.

It is true that the stars having the greatest proper motion are mostly faint stars, but this is not inconsistent with the relationship which has just been referred to, for as the number of faint stars is so much greater than the number of bright ones, a much wider range might be expected amongst the amounts of the individual proper motions.

These alterations in the position of the stars might arise from one or both of two causes: from a real change in the position of the stars, due to their actual motion in space; or from an apparent change in their positions, due to an actual motion of our solar system in space,—for if the stars be supposed to be moving, why not our own sun, which is merely a similar body?

Explanation of proper motion.

There would be no difficulty, however, in distinguishing between the motion due to these two causes; for that due to any motion of our sun in space would be symmetrically distributed in opposite directions on either side of the path of the sun in space, whereas no such symmetrical distribution could be expected in that due to the actual motion of the stars.

By considering the general tendency of the direction of the proper motions of the stars, several attempts have been made to determine the direction and amount of any motion of the solar system. All agree in fixing on some point within the constellation Hercules—somewhere, probably, between ρ and λ Hercules—as the point towards which the sun is moving. The rate of this motion is by no means so certainly fixed, but would appear to be about one hundred and fifty million miles per annum, or five miles per second.

Motion of solar system.

It was supposed by Mädler that the solar system might be only one of a great system of suns revolving round their common centre of gravity, or even round one great central sun; and he was led to suppose that this central luminary might be *Alcyone*, or η Tauri, the brightest of the Pleiades. Our present knowledge of the proper motion of the star, however, is not sufficiently great to enable any real conclusion being drawn on such points as these, but in time data will be gradually accumulated, which will lead to our being able to determine whether there is any probability of the truth of such a striking hypothesis, that the entire universe may be members of one grand system, ruled over by one giant central member.

COSTUME IN THE TIME OF CHARLES II.

XLIII.

CHARLES II.

THE reign of Charles II. began amid universal rejoicing. It was destined to close amid universal dissatisfaction and distrust. The whole nation was disposed to give the restored king credit, at his accession, for every royal virtue, and to believe in his desire and intention to rule for the good of his people. But these fair hopes were soon lost. Charles was an intensely selfish man, without gratitude, honesty, or conscience. To live a pleasant and luxurious life, to enjoy to the utmost all the sensual and material pleasures fortune threw in his way, to gratify all his desires by lawful or unlawful means, such was the course he pursued throughout the whole of his reign; and the period of the Stuarts' restoration was one of dishonour and shame to England.

Accession of of Charles II.

Nature of his rule.

The satirical mock epitaph that described him as the king who never said a foolish thing, and never did a wise one, was not altogether devoid of truth. Charles II. had excellent abilities, and could form a sound judgment on most subjects of state. He could even see with sufficient accuracy the two courses that lay before him, and the effect that would respectively arise from his following the path of honour or of self-indulgence. His indolence and want of principle caused him deliberately to choose the bad path; nor did he seem to feel the degradation when he reduced the country, lately raised to a supreme position in Europe, to a state of vassalage, and of dependence upon France. Occasionally, for a moment, the idea of a manly resolution seems to have flitted across his mind, as on that occasion when he laid his hand on Sir William Temple's shoulder, and declared that he would be "the king of his people"; but he had not resolution to keep to a good decision even for a day. He was the slave of his own vices, and it was through these vices that designing men with ambitious ends, like Louis XIV., could most easily and surely influence him for their advantage.

His character.

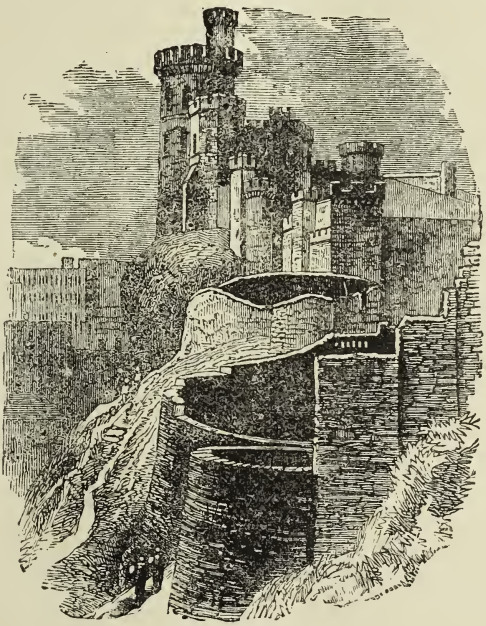
Yet he was never an unpopular king. A certain appearance of good-nature, a politeness of speech and manner that hardly ever failed him, an affable familiarity in his intercourse with his subjects, that was yet "by no means vulgar," gained for him the popular suffrage; while his one fixed determination, never to "go on his travels again," never to risk a second exile, acted as a check upon his ambitious temper, and kept him from committing such follies as cost his brother James the crown.

His popularity.

The Convention Parliament showed itself anxious to prove its loyalty to the king by granting him the most liberal supplies; though no amount of money would have kept Charles out of debt. Nearly the whole of the great parliamentary army was disbanded after receiving arrears of pay; and Oliver's soldiers were thus quietly absorbed into the civilian population. From the Act of Pardon and Indemnity, which professed to consign to oblivion all offences committed against the crown, the regicides were excluded. Those who had been concerned in the late king's trial, and now surrendered themselves to the government, were imprisoned for life; some escaped abroad, like Ludlow and Broughton, who took up their residence at Vevay, on the borders of Lake Leman; a few, like the resolute Sir Harry Vane, were executed. The vengeance of the government extended even to the corpses of their enemies; for the remains of Bradshaw, and Ireton, and of the great Protector himself, were dug up out of their graves, and exposed on gibbets at Tyburn.

Act of Oblivion.

Vengeance on the late king's judges.



EDINBURGH CASTLE.

Among the king's advisers and the great officers of his household, at the beginning of his reign, were Edward Hyde, Earl of Clarendon, the Lord Chancellor, whose daughter Anne was married to the Duke of York, the king's brother, and whose two granddaughters, Mary and Anne, afterwards became queens of England; the Marquis, afterwards Duke of Ormond, the most honest and faithful of the cavaliers; General Monk, who was created Duke of Albemarle for his prominent share in the Restoration; and the Duke of York, who was appointed Warden of the Cinque Ports and Lord High Admiral.

The Convention Parliament having been dissolved at the end of 1660, a new parliament was summoned in the May of 1661. It was known by the name of the Loyal Parliament, and was chiefly remarkable for its ready subserviency to the king. In duration it almost rivalled the celebrated Long Parliament, not being finally dissolved until the beginning of 1679.

The Loyal Parliament, 1661–1679.

That the restored monarchy would bring with it a restored episcopacy was to be expected; and, accordingly, no wonder was excited when the survivors among the bishops who had been excluded by the commonwealth were re-established in their sees and in their places in parliament. A promise made by the king soon after his accession that the objections of the nonconformists to the liturgy should be considered, coupled with his former pledge of freedom of conscience for all his subjects, quieted the apprehensions of the Presbyterians, Independents, and other sects of nonconformists; and there were hopes of a reign undisturbed by religious controversy.

Church matters.

But it soon appeared that these hopes were fallacious. Already, in 1661, an order was issued for the closing of conventicles, explained to some extent by the uneasiness caused by the mad outbreak of the Fifth Monarchy men, in January of that year. Soon after, however, other ordinances followed in the same direction. All members of parliament were compelled to take the sacrament according to the form of the Anglican Church. Then came the Corporation Act, which, besides upholding the doctrine of non-resistance, obliged all municipal office-holders to take the sacrament in the Church of England form. The Solemn League and Covenant was pronounced unlawful. These measures were only preliminaries to the Act of Uniformity, which declared ordination by a bishop to be necessary for the holding of any ecclesiastical office, insisted on acceptance of the Book of Common Prayer by all clergymen, schoolmasters, and members of universities; while the doctrine of non-resistance and the abjuration of the Covenant were equally insisted on. For their refusal to subscribe to this Act, which was a direct violation of the promises made by Charles at Breda, nearly two thousand clergymen were deprived of their livings, and reduced with their families to poverty. The Conventicle Act, passed in 1664, went still further. It declared every assembly of more than five persons for worship, otherwise than according to the Book of Common Prayer, to be

Corporation Act.

Act of Uniformity.

Conventicle Act.

unlawful, punishable with fine, imprisonment, and, on a second repetition of the offence, with transportation. Before this time already the same penalties had been denounced against Quakers assembling for public prayer. The Five Mile Act, passed in 1665, was a crowning piece of tyranny in ecclesiastical matters. It forbade all clergymen who had not taken the oath of non-resistance, or subscribed to the Act of Uniformity, to come within five miles of the place where they had been ministers, or of any corporate town; and contained a prohibition preventing them from acting as schoolmasters, thus closing another avenue of livelihood against them.

The Church in Scotland.

In Scotland a similar policy was pursued. The king renewed the attempt, made years before by his father, to force episcopacy and the liturgy of the Anglican Church upon the Scots. One of the Presbyterian ministers, Sharpe, despatched by his brethren to London to remonstrate against these proceedings, was gained over by the government, and was rewarded by being made Archbishop of St. Andrews. This was the beginning of a strife in Scotland that continued with increased bitterness until the end of Charles's reign. An attempt to compromise the quarrel by granting an indulgence to a certain number of Presbyterian clergymen to hold services under certain conditions, only embittered the strife. The Covenanters denounced the black indulgence "as a soul-destroying snare." Driven from their places of worship, they held meetings on the moors, and in desert places by the hill sides. Cruel persecution, military tyranny, the infliction of torture, only made them more determined in their resistance, which, towards the end of the reign, culminated in open rebellion, that could be put down only by the sword.

Archbishop Sharpe.

Profligacy of the government.

The shameless profligacy of the king, and the licence of his favourites and followers, soon rendered the court of Whitehall a byword among the nations. Charles showed himself ready to sacrifice the country's honour and his own for the means of pursuing his pleasures. He married the Portuguese princess, Catherine of Braganza, for the sake of the sum of £500,000, which, with the town of Tangier, she received as a dowry, and then systematically neglected and insulted her by living openly with his various mistresses. In spite of the exceptional liberality of the parliament, his profligacy kept him continually in debt; and this fact was turned by the astute Louis XIV. to his own advantage. He considered that Charles might be induced for money to sell the position of England among the nations, and his own honour as her king; and the result proved his judgment true.

War with Holland, 1665.

Quarrels between the merchants of England and Holland on the African coast produced a Dutch war in 1665; and here it was seen how far the government of England had degenerated from what it had been when the Protector ruled at Whitehall. Where the fleets of the English and the Dutch met in fair fight, as in the action of the 3rd of June, off Lowestoft, between the Duke of York and Admiral Opdam, the old renown of British valour was maintained; but the mismanagement was deplorable. The large sums voted by parliament for the prosecution of the war were diverted to other purposes; ships were sent to sea in a disgraceful condition, and others could not be put in commission at all for want of men and stores. The sailors mutinied for their pay; and all the time the extravagance and profligacy of the king and his court went on increasing. The English name abroad, never so high as when Oliver wielded the sceptre, sank lamentably during this Dutch war; and the lowest depth of humiliation was reached when De Ruyter, in revenge for the burning of an unarmed town by the English, sailed with his fleet up the Thames, in June 1667, burnt Sheerness, destroyed the shipping at Chatham, and captured an English ship, the *Royal Charles*. The Dutch fleet advanced as far as Tilbury, and, as as Lord Macaulay observes, "the roar of an enemy's guns was heard, for the first and last time, at the Tower of London." Shortly afterwards a treaty, far from honourable to the British, was concluded at Breda, in July 1667,—a very different compact from those the Protector had been accustomed to sign after a war.

De Ruyter in the Thames, 1667.

Treaty of Breda.

London had been at various times visited by pestilence; and, indeed, it could hardly be otherwise, considering the unhealthiness of the conditions of life in the crowded, uncleansed city; but all former visitations were trivial compared with the terrible plague that in 1665 carried off 100,000 inhabitants of the metropolis between the months of April and December. In September the deaths rose to 10,000 a week, and the most frequented thoroughfares of London were grass-grown and deserted, while the fatal cross, with the inscription "Lord, have mercy upon us," upon a vast number of padlocked and guarded doors, gave melancholy token of the long list of infected houses. The court and parliament fled to Oxford in dismay; and even the majority of the metropolitan clergy, seized with panic, quitted the stricken city, leaving its unhappy denizens to their fate. With the coming of cooler weather the scourge abated.

The Great Plague, 1665.

The following year brought another calamity, whose magnitude justified Dryden in bestowing upon 1666 the epithet "Annus mirabilis." By the great fire of London, that raged from the 2nd to the 9th of September, the greater part of the capital was laid in ashes. From Tower Street in the east to Temple Bar in the west, from the bank of the Thames to the confines of Smithfield, all was down. St. Paul's Cathedral was destroyed, with eighty-nine churches and above thirteen thousand houses. This was one of the few occasions on which the king roused himself from his ordinary apathy. With his brother, the Duke of York, he visited the scene of the conflagration, giving the necessary orders for arresting the fire.

Fire of London, 1666.

SOUND, LIGHT, AND HEAT.

By THOMAS DUNMAN.

I.

SOUND.

ONE great result of the rapid strides made by science during the present century has been the general acceptance of the belief that there are in this universe but two things with which scientists have to do—Matter, and Energy ; the former being perhaps best defined as "that which has weight," the latter being a condition or affection of the former. In treating of these two in their various forms, science is naturally divided into numerous branches, each branch being concerned with certain allied phases of matter or of energy. To that science which treats of the elementary conditions and properties of matter in general, together with the investigation into the laws and phenomena of Sound, Light, Heat, Magnetism and Electricity, the name of "Physics" is generally applied ; while this again is frequently subdivided into two branches, one treating of the closely-allied sciences of Sound, Light, and Heat, the other of the equally similar sciences of Magnetism and Electricity.

The latter are fully treated of elsewhere in this work, and we now propose to take up the other branch of Physics, commencing with a consideration of the laws and phenomena of Sound. For a knowledge of such elementary properties of solids, liquids, and gases as is necessary for the full understanding of these phenomena, we must refer our readers to the opening chapters of the articles on Mechanics, which have already appeared, and to the articles on Hydrostatics and Pneumatics, which will shortly appear, in the UNIVERSAL INSTRUCTOR.

Nature of Sound.

The first thing into which we have to inquire is obviously the nature of sound ; to which of the two categories does it belong ? Is it matter or energy ? *Weight*, we have seen, is the test of matter, and as it may easily be demonstrated that a sounding body weighs no more than it does when silent. it is evident that Sound cannot be matter, and must therefore be a form of Energy.

Sound waves.

Sound, in fact, is *motion*, and we have now to inquire how sound is propagated from the sonorous body to the ear. In order to fix our ideas, let us imagine the sounding body to be a bell-glass struck with the fingers, or with a violin-bow, in the ordinary way. When this bell is struck it begins to vibrate—that is to say, it is set in rapid motion, bending first outwards, then inwards, and striking against the particles of air by which it is on all sides surrounded. For the sake of perfect clearness let us imagine only a single row of such particles extending as a chain between a point of the bell and the ear of the listener. When the bell is first struck it pushes against the first particle in our imaginary row, and drives it towards the second, —and, being elastic, the first particle passes on the push which it has received to the second, the second for the same reason passes it on to the third, the third to the fourth, and so on all along the line, until the last particle pushes inwards the membrane of the drum of the ear (or, as it is termed, the tympanic membrane), and in this way the push is propagated from the bell to the ear. But directly the bell has pushed against the first particle of air it begins to retreat, and cause a vacuum ; moreover, the elastic air particle having been driven forward tends to swing backward an equal distance ; the same is the case with the second particle, the same with the third, and so on, until the tympanic membrane of the ear itself swings backwards and is thus set in vibration. In this manner the air particles and the tympanic membrane continue to swing backwards and forwards, in unison with the vibrations of the bell, until the latter gradually cease and the sound no longer is heard.

Illustration of the propagation sound waves.

In order that we may fully comprehend the manner in which the vibrations of the bell may be communicated to the air, and by the latter to the ear, one or two simple illustrations may be given. Every one has seen an engine backed against a train of luggage trucks at a station. The engine strikes the buffers of the first truck ; this passes the blow on to the second, and so on along the whole line, the passage of the impulse being sufficiently slow to be detected by both ear and eye ; this exactly corresponds with what takes place when the particles of air are struck by a sonorous body. After the engine has been attached to the trucks the train is started, and in precisely the same way as the *push* was passed along the train, a *pull* is now slowly propagated. Here again we have an example of what happens when the air-particles follow the retreat of the sounding body. Now, it is evident that if we have a row of air particles of any length, the first few particles will begin to make their first swing backwards long before the first push reaches the ear, and hence we shall have our row of particles divided into several portions, in some of which they will be nearer together, and in the others farther apart than usual ; this may be represented as in Fig. 1.

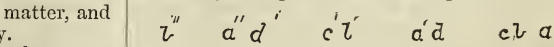


FIG. 1.

Condensation and rarefaction.

From *a* to *b* the air particles are driven close together, or, in other words, the air is condensed, while from *c* to *d* the particles are drawn apart, or the air is rarefied. Each of the portions of the air in which the particles are driven together is termed a *condensation*, each of the portions where the air particles are drawn apart is termed a *rarefaction*, while a condensation and a rarefaction taken together constitute a *wave of sound*. The term *vibration* is in England defined to be the passage of a particle from a state of rest once to *and* fro back to a state of rest ; on the Continent a

vibration is taken to be the passage of a particle to *or* fro from a state of rest; a Continental vibration is therefore equal only to half an English vibration.

If, as in fig. 2, a row of boys be so placed that each one has his hands upon the shoulders of the boy in front of him, and a push be administered to the hinder one A, the front boy D will be pushed forwards, while the intervening ones B and C will only move slightly forwards and backwards, and come to rest. The push is propagated from A to B, B to C, and C to D, but the latter having no one to whom he can pass on the push is compelled to fall forwards, and had he been in contact with a sheet of glass he would have been pushed through it. Again, if, as in fig. 3, we have a row of glass marbles placed quite close to each other, and in any way strike the hinder one, only the front one will move. Now, in both these cases the elasticity of the muscles or of the glass acts precisely as does the elasticity of the air; and what it is particularly necessary that we should notice is that each individual of the row, except the foremost, merely swings to and fro for a short distance: the *shock* is propagated, but there is no actual translation of the individual bodies struck. So is it with the particles of the air or other medium through which sound passes. The distance through which each particle swings is termed the *amplitude* of a wave of sound; the length of a wave of sound is the distance from one condensation to the next, or from one rarefaction to the next; the length of a wave of sound will therefore considerably exceed its amplitude.

Amplitude.

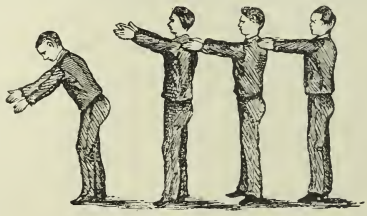


FIG. 2.

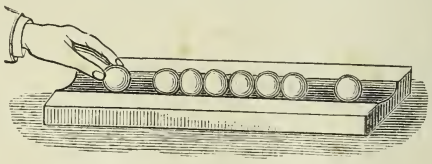


FIG. 3.

It is absolutely necessary that some medium should be present in order that sound may be transmitted. This is fully demonstrated by the common lecture experiment of ringing a bell by clockwork under the receiver of an air-pump. The bell being set ringing the air is gradually pumped out from the receiver (fig. 4), and as the air is withdrawn the sound becomes feebler, and eventually ceases, although the bell may still be seen to be ringing. Upon readmitting the air the bell again commences to sound, its sound increasing in intensity as the amount of air in the receiver approaches more and more nearly the normal quantity.

There can be no sound in a vacuum.

The rate at which Sound travels in air is determined with comparative ease, though, as in all scientific experiments, great care has to be taken to avoid error. The velocity of sound in air has been practically determined upon several occasions. It must have been observed by every one that light travels much faster than sound; if we watch the firing of a gun at some little distance from us we see the flash before we hear the report; if we watch a woodcutter at work from a distance we see the blow of his axe before we hear the sound of the blow; we hear the roll of the thunder *after* we have seen the flash of the lightning. The passage of light, in fact, for all practical purposes on the earth, may be considered as instantaneous; and we have therefore only to note carefully the time which intervenes between the perception of a flash from a gun and the hearing of the report, to measure carefully the distance between the gun and the observer, and to divide the distance by the number of seconds, in order to arrive at the required result. As the mean of several experiments it has been found that the velocity of sound in air at the freezing temperature is 1090 feet per second.

Velocity of Sound.

The fact of our fixing a certain temperature when speaking of the velocity of sound indicates that temperature must have some effect upon that velocity. This indeed is so, it being found that for every degree of the centigrade thermometer above freezing point the velocity of sound in air increases very nearly two feet per second, and *vice versâ*.

Influence of temperature.

The velocity of sound in air or in any other medium depends upon the relation between the elasticity and the density of that medium. As this is a fact of great importance, and is, moreover, one which is frequently very imperfectly understood, we would request our readers' careful attention to the following considerations.

Elasticity and density.

An increase in the elasticity of any medium is *by itself* favourable to an *increase* in the velocity of sound; an increase of the density of any medium causes *by itself* a *decrease* in the velocity of sound.

Correctly stated, the law is found to be as follows:—The velocity of sound in any medium is directly as the square root of the elasticity, and inversely as the square root of the density. In other words, quadruple the density, and you halve the velocity of sound; but if you quadruple the elasticity, the velocity of sound will be doubled. It is therefore clear that density and elasticity affect the velocity of sound in any medium in directly opposite ways to precisely the same extent. It must be carefully borne in mind that in considering the velocity of sound in any medium we have not to consider the elasticity of that medium *only*, or its density *only*, but *the relation which one bears to the other*.

XVI.

Centres or Mean Points.

§ 70. Once more we draw upon the store of scientific ideas that lie latent in popular phraseology. The conception we are about to utilize is that of the "middle," or "mean," or "centre." It is necessary to give precision to the idea, and in doing this we get great help from the common arithmetical definition of a mean. To find the mean of several numbers we add them together and divide the result by the number of numbers. For instance, the sum of 7, 11, 12, is 30; the mean is found, by dividing this by 3 (because there are three numbers added together), to be 10.

A similar process is available for our present purpose. Suppose we wish to find the centre of three particles of equal mass situated at A, B, C, as in fig. 40. Taking any point, P, the positions of A, B, C are known when we know the lengths and directions of the three lines PA, PB, PC. It will be convenient to call these lines *vectors* when we take into account their directions as well as their lengths. The reader will be familiar with the use of these vectors, for we have already represented velocities, forces, etc., by means of vectors. This premised, we can at once translate the arithmetical rule above given into the form we require. It is: Add together the vectors of the particles, divide the sum by the number of particles; the result is the mean or centre vector, and the centre is thus determined.

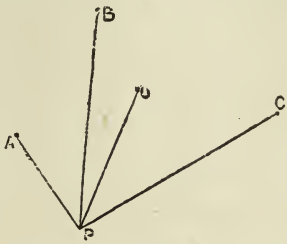


FIG. 40.

Vectors.

Definition of mass centre.

In the case of fig. 40, for instance, we should proceed thus: The first vector, PA, is already drawn: from A we draw a line equal and parallel to PB (the second vector); from the end of this line draw a line parallel and equal to the third vector, PC. Let the end of the last line drawn be called D, then the result of adding the three vectors. PA, PB, PC, is PD. One-third of this, PO, is the mean vector, and O (as in fig. 40) is the centre. We have, of set purpose, left the drawing, fig. 40, incomplete. Our object was to incite the student to draw the figure for himself; for drawing the figures, seeing them grow instead of already full-grown, is almost as powerful an aid to the comprehension of the theory of mechanics, as experiment is to a mastery of its practical applications.

Example.

§ 71. There are two remarks about the process just described which are of great importance. The first is that the vectors may be added *in any order*. In the above example PB was added to PA, and PC to the result; but we might have taken them in any other order without affecting the conclusion. This may easily be verified by trial, but it is well to note that it is only another way of saying what has already been said in § 6. The use of this remark will shortly appear.

The second point is that we get the same result, no matter where the point P is taken. The proof of this will give the reader some notion of the mode of working with vectors, and perhaps will be interesting, if only on that account. The definition of the centre, as above given, is expressed by the equation

$$\tfrac{1}{3}(PA+PB+PC)=PO \qquad (1)$$

where PA, etc., represent vectors and not merely distances. Now, suppose we take another point, Q, for our starting-point, we have to prove that

Starting point indifferent.

$$\tfrac{1}{3}(QA+QB+QC)=QO \qquad (2)$$

for then we arrive at the same point, O, for centre, whether we start from P or from Q. To prove (2) we observe that

$$QA=QP+PA,$$

for this only expresses that by going straight from Q to A we get to the same place as if we went from Q to P and then from P to A. In the same way

$$QB=QP+PB$$
$$QC=QP+PC.$$

From these three equations we find

$$QA+QB+QC=3.\ QP+PA+PB+PC,$$

so that

$$\tfrac{1}{3}(QA+QB+QC)=QP+\tfrac{1}{3}(PA+PB+PC)$$
$$=QP+PO \text{ by (1)}$$
$$QO,$$

and this is what we wanted to prove.

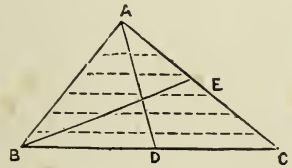


FIG. 41.

In a similar manner it may be shown that

$$OA+OB+OC=0,$$

which suggests a useful method of testing the accuracy of a determination of a centre, and might be used as a definition.

Since we may take the starting-point, P, anywhere we like, it is well to choose it so as to lessen the work as much as possible. For instance, in fig. 40, if we take the starting-point at A, we should only have to add two vectors, namely, AB and AC, to find the position of O. It is to be noted that the divisor is still 3, for there are still three particles concerned.

If the particles are not of equal mass, as we have assumed hitherto, we may suppose them replaced by an equivalent number of equal particles. For example, if the mass of the particle at A (fig. 40) is twice that at B or that at C, we may suppose that there are two particles at A. Now, if we take A for our starting-point, we shall find the centre of the four particles by adding the two vectors AB, AC, and dividing their sum by 4. If, in this same example, we take the starting-point at P, we should add together

Unequal masses.

the *four* vectors PA, PA, PB, PC, and divide the sum by 4. Observe that the vector PA comes in twice, because there are two particles at A.

§ 72. It is worth while to consider specially the case of particles lying in one straight line. If we take the starting-point P in this line, all the vectors lie in the line, and only differ in length. The determination of a centre in this case is simply a matter of arithmetic. We shall illustrate by an example worked out. Say there are three particles, A, B, C, whose masses are 2, 8, 7, respectively, and suppose that the distances, AB, BC, are two units and three units. We may also express this by saying that there are two particles at A, eight at B, and seven at C, all of which are equal. We will investigate how far the mass-centre is from A. The distance from A to B is 2. This must be counted for each of the eight particles at B, giving altogether, 16. The distance from A to C is 5, and taking this for each of the seven particles at C, we get 35. Thus the sum of all the vectors is 51. The number of equal particles is 17, viz., 2 at A, 8 at B, and 7 at C. Hence the distance of the mass-centre from A is $51 \div 17 = 3$. The reader will find the same position for the mass-centre if he selects any other point as his starting-point; but it must be remembered that if the starting-point is out of the line A B C, the vectors are in different directions and cannot be added by simple arithmetic, but by making a figure.

Particles in a line.

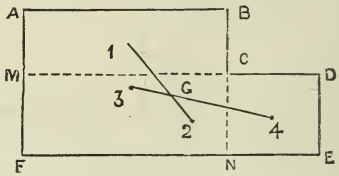


FIG. 42.

An important case—important because it often arises—is when two masses only are concerned. Their centre lies in the straight line joining the two particles; and its position in the line is found precisely as in the example given above, when the third mass, C, is left out.

There is a method of finding the mass-centre of several particles (not necessarily in a line), which is based upon this case. Suppose, for instance, it is required to find the mass-centre of five particles A, B, C, D, E. Find the centre of A and B, and suppose the two particles A, B to coalesce at their centre to form a new particle F. Similarly we may suppose C and D to coalesce at their centre to form a particle G. Next, F and G may be combined to form one particle H at a proper place. Finally, H and E may be united. In each operation we suppose a pair of particles to be joined together at their centre, and the result of all the work is that we have all the particles united at their mass-centre. It will, however, probably be found that the process of § 70 is quite as convenient.

Second method for mass centre.

§ 73. To find the mass-centre of a body composed of a very large number of particles is a matter that generally requires the aid of the integral calculus to render it practicable. There are, however, many cases in which this assistance may be dispensed with, and the problem solved by very simple reasoning. In a straight and uniform rod, for instance, the mass-centre is midway between the ends. In a circular disc, or a ring, or a ball the mass-centre is at the point commonly called the centre; the reason in each case being that we can divide the body into pairs of particles, so that the mass-centre of every pair is at the centre of the body. The mass-centre of an oblong, for the same reason, is at the point where the two diagonals cross each other.

Special cases.

It is rather more difficult to find the mass-centre of a triangular disc, but it is worth while to see how it is done, and the result is useful. Suppose the disc to be cut into a number of very thin, uniform rods, by slits running parallel to one of the sides. A few of these slits are indicated by the dotted lines in fig. 41. The mass-centre of each rod is at its middle point. Now all these middle points lie along a straight line. The middle points of the rods parallel to BC (fig. 41) all lie on the straight line from D (the middle of BC) to A. Hence the centre of all the rods—that is, the centre of the triangle,—must be somewhere in AD (§ 72). But now if we made slits parallel to AC it would be found that the mass-centre of the triangle must be on the line joining B to E, the middle point of AC. Accordingly the mass-centre of the triangle is at G, the point where BE crosses AD. It will be found that GD is one-third of AD, and that G is also the mass-centre of three equal particles placed at A, B, C.

Triangle.

The mass-centre of a body of other shapes may frequently be found by considering it divided into portions, the mass-centres of which can be determined. As an example, take the disc ABCDEF in fig. 42. We may suppose this divided into two oblongs by the dotted line CM. The centres of these, found by drawing the diagonals, are at 1 and 2. Therefore the centre of the whole figure is somewhere on the line 1 2. To find where it is, we may either use the method of § 70, if we know the masses of the two oblongs, or we may divide the figure in a second way, by means of the dotted line CN. The centres of the two oblongs thus obtained are 3 and 4. As before, the mass-centre must lie on the line 3 4; and the only position it can have is G, the point where 3 4 and 1 2 cross.

Another example.

XLIV.

THE SYNTAX OF THE VERB.

Words governing the Verb—the Accusative before the Infinitive.

BY the syntax of the verb I mean two distinct things—first, the government exercised on the

verb by some word or words in the sentence, which govern it in a particular mood or tense, or person—as in *Dicit se venturum esse*, he says that he will come; and *Quòd tu doleas, doleo*, I am grieved that you grieve. Now the verb *venturum esse*, in the former example, is in the infinitive mood, because it is governed by the verb *dicit;* and in the second example, *doleas* is in the subjunctive mood because it is governed by *quòd*, which governs a subjunctive mood. Secondly, I mean the government exercised by the verb on other words in a sentence—as in *Te amo præter omnes alios*, I love thee beyond all others; and in *Omnes fruuntur magnâ victoriâ*, all men enjoy a great victory. Here observe that *te*, in the former sentence, is governed by the verb *amo* with an accusative case; and in the second sentence observe that *victoriâ* is governed with the ablative case by *fruuntur*.

The accusative case governing the verb in the infinitive mood:

(1) The accusative case and infinitive mood are used after verbs of *saying, hearing, seeing, thinking, knowing*, etc., and after such expressions as "It is well known," "It is certain," "It is likely." One sentence, well looked at and thoroughly understood, will make this always come easy to the pupil—*Videmus aves auctumno in alias terras migrāre*, we see that birds migrate into other lands in autumn.

Here we have an accusative case *aves* and an infinitive mood *migrāre*. We take *videmus*, according to the old but never-to-be-forgotten rule—"Take the nominative case first, and, if there is not one, take the verb, and put in a nominative";—then we will take *aves*, not as the accusative case after *videmus*, but as the accusative case before the infinitive mood *migrāre*; before the accusative case, we will put in the most important word THAT; and, as *migrāre* is the present infinitive, we will construe it as if it were the third person plural of the present indicative—*aves*, that birds, *migrāre*, migrate. And the way to parse such a sentence is—*aves*, accusative case before the infinitive mood *migrāre; migrāre*, infinitive mood after the accusative case *aves*.

In turning such a sentence into Latin—"We see that birds migrate," we leave out the word *that*, turn what might be the nominative into the accusative, and put the verb in the infinitive mood; instead of, as learners might think they were to do, using *ut* with the subjunctive.

It may be noted here, without entering more fully into the subject, that the accusative with infinitive always states a fact, and that no English sentence can be, in Latin, turned into accusative and infinitive unless we can insert the words "as a matter of fact": *e.g.*, "I hear (as a matter of fact) that Vesuvius has been vomiting lava." When these words cannot be inserted, the sentence is to be rendered by *ut* with the subjunctive.

(2) The accusative before the infinitive is the regular case after various impersonal phrases—such as *certum est*, it is certain; *manifestum est*, it is clear; *æquum est*, it is fair; *opus est*, it is necessary; *constat*, it is an established fact; *sequitur*, it is a result; *expedit*, it is expedient: and other such phrases—as *eorum erat confessio, sententia*, etc., *reliquum est*, it was their confession, opinion, it remains that: as in *Certum est liberos a parentibus amari*, it is certain that children are loved by their parents.

(3) Verbs signifying *willingness, permission, determination, duty, lawfulness*, govern the *infinitive* mood even without a preceding accusative case—as in *Dici beatus ante obitum nemo debet*, no one ought to be called supremely happy before his death.

(4) The infinitive mood is often governed not by any word expressed in the sentence, but by some word or phrase *understood*, and this is called the historic infinitive mood—as in *Suo quisque metu pericula metiri*, each one (began) to measure his dangers by his own fear. This often occurs in descriptive passages, and we must often supply as an example the verb *cœpit*, he began, or *visus est*, he appeared.

Exercises.

Translate into English the following passages from Latin authors:—

Clamabant homines, fore ut ipsi dii immortales urbe excederent. Illa vetera et stolida morari jampridem desino. Amicitia, nisi inter bonos homines, esse non potest. Cupio me esse admodum clementem, senatui nostræ patriæ placuit, illam Syriam provinciam obtinere. Necesse est igitur legem haberi in optimis rebus, id quod justissimum est. Cato negat jus esse, eum qui miles non sit, cum hoste pugnare. Manifestum est hunc locum tibi minimè placere. Auctores sumus tutam ibi majestatem Romani nominis fore. Miror te adesse mihi rescribere. Inferiores non dolere debent se a suis superari. Thales Milesius aquam dixit esse initium rerum. Sensit animus se moveri. Titus Cæsar dicere solebat, neminem tristem a Principe discedere debere. Mathematici docent, terram nostram circa solem trecentis sexageni quinque diebus cursum suum conficere. Sæpe nos videmus, homines vel propter leviora delicta in gravissimas calamitates incidere. A poetis accepimus, antiquissimis temporibus homines in summâ innocentiâ et morum integritate vitam degisse. Græci philosophi quum sentirent, se ceteros populos cultu et artibus superare, peregrinos omnes barbaros appellabant. Constat, Romanos eodem anno duas urbes florentissimas, Carthaginem et Corinthum, delevisse. Credimus. Deum hunc mundum creavisse, creatumque conservare et regere. Tum scis me jamdudum de te nihil audivisse, nec literas a te accepisse. Non turpe est parum scire, sed in inscitiâ suâ culpâ permanēre. Non est æquum, minori parēre majorem. Omnibus bonis maximè expĕdit, quemque reipublicæ leges observare, et parēre magistratibus.

Translate into Latin:—

Thales of Miletus (*Milesius*) used to say (imperfect) that water was the beginning of all things, a thing which reminds us of the teaching of Moses respecting the creation. I know well that this is your opinion. It is necessary that bad men should pay the penalty of their crimes, and not escape it. They are

not sorry that they have done wrong, a thing which I cannot at all understand. It is acknowledged by all men that laws have been invented for the safety of the citizens. They inform Cæsar that it is not an easy matter to drive away the enemy from the towns. It is evident that I am a physician. The physician says that he is skilful. They hope that they shall be brave. He says that he has concealed the knives. They say that the good man is free. It is evident that I was born a poet. The army hopes that it will surround the city. I hope that I shall be happy. We know that the Dictator Julius Cæsar was killed by his friends Brutus and Cassius. The poets all say that hope considers the sad and the poor. We believe that in every year there are three hundred and sixty-five days and some few hours. We know that no horse is so swift as the stars. It is agreed that birds fly. It is agreed on all hands that vipers are mischievous. Who is there that does not know that the cow is still alive? And yet we all know that the tune was not sweet. The cat thinks that fish are sweet food. The wolf knows that he has lost his teeth. I am sure that this man is kind, but not sensible.

Self-Examination Questions.

What do you mean by the syntax of the verb? Give an example of each of its two senses. Mention the particular cases in which we have an accusative case before the verb in the infinitive mood. Is the infinitive mood ever used without the accusative?—give examples. Is the infinitive mood ever used without any verb or noun to govern it? Give an example, and state what the infinitive mood is generally called.

XL.

GREECE (*concluded*).

FOR some years after the events narrated in our last article, the Athenians continued to gain victories at sea, but at last, in B.C. 405, their whole fleet was captured. Athens was surrounded on land by the Spartan army, and her port, Piræus, was blockaded by the Spartan fleet, so that no food could reach her from the sea, as on all former occasions; and in the spring of the next year she was driven to surrender, and to sign a peace by which she gave up all her possessions and agreed to demolish the "long walls" and the fortifications of Piræus, thus putting an end to her dreams of empire, and even to her own security against capture.

Surrender of Athens.

A government of thirty nobles was now set up, but after a few months of cruel misgovernment, in which they earned the nickname of the "Thirty Tyrants," they were driven out and the democracy re-established.

"The Thirty Tyrants."

A few years later an army of 14,000 Greeks joined Cyrus, the younger brother of Artaxerxes, the king of Persia, in an attempt to overthrow that king, and marched into the heart of the Persian empire. A great battle was fought, in which the Greeks routed the wing opposed to them, but Cyrus was killed, and his wing, composed of Asiatics, defeated. The Greeks were obliged to retreat. They elected Xenophon, a young Athenian knight, their general, and under his leadership commenced a weary homeward journey of nearly 2000 miles through unknown and hostile countries, without guides, harassed by the Persians, who hung on their rear, and often nearly perishing from hunger and thirst. Their escape was one of the most marvellous things in the history of military adventure, and their leader, Xenophon, wrote a thrilling account of it, which every schoolboy makes acquaintance with in the course of his Greek studies. To the student of history the expedition is chiefly interesting as showing how immensely superior Greek soldiers were to Asiatics at this time, and how weak the Persians must have been to let a few thousand invaders slip through their hands so easily. It helps us to understand the apparently marvellous ease and rapidity of Alexander's conquests in Asia some sixty years later.

Expedition of Cyrus.

Retreat of "the Ten Thousand."

After the capitulation of Athens, Sparta ruled almost all Greece; but her supremacy was soon disputed by Thebes, which had been gradually rising in importance as Athens was sinking. Thebes at this time possessed the greatest general in Greece. His name was Epaminondas. He made Thebes for the moment the most powerful state in Greece, defeating even the Spartans and carrying the war into Peloponnesus. But he was killed in one of his victories, and Thebes sank again into insignificance.

Rise of Thebes.

In looking back over the history of Greece, from the point which we have now reached, we see the Greeks maintaining their independence gallantly against foreign foes, but distracted by never-ending quarrels between themselves. The principal figures in these quarrels are Athens and Sparta, round whom the lesser states generally grouped themselves. At first Sparta is the more powerful; but after the Persian invasion, which called forth all the latent energies of the Athenians, Athens comes to the front, and, chiefly by her great naval power, makes herself the greatest influence in the Greek world. But a combination of the other states, under the leadership of Sparta, after a long and bloody struggle, reduces Athens again to the second place, and Sparta regains the first place. Then for a short time Thebes presses into the front, and even Sparta is humbled, but the power of Thebes dies with her one great man Epaminondas. Athens again regains a portion of her former influence, and in the struggle for life which all Greece is now about to engage in against a new and "barbarous" enemy, she is once more found leading the states—but *not* to victory. The great Peloponn-

Brief resumé.

nesian war, in which Athens was ruined, and the sharp but severe struggle between Thebes and Sparta, had fatally weakened and exhausted Greece, and made her an easy prey to the new and terrible foe whose appearance in Greece we have now to record.

Effects of internal wars.

This "barbarous" foe was Macedonia, led by her king, Philip. Macedonia lay to the north of Greece. The people were probably Illyrians, and not Hellenes. Up to the period at which we have now arrived, the history of Macedonia has little to interest us. Philip had fallen into the hands of the Thebans as a youth, and had been kept by them at Thebes for some time as a hostage. There he learned the newest methods of war from Epaminondas, and no doubt perceived the weakness of the Greek states. At the age of twenty-three he became regent of Macedonia, his infant nephew being king. But he soon deposed his nephew, and usurped the crown himself. He kept a standing army of 20,000 men, which he brought to a very high state of discipline. Soon he came into collision with the Athenians, who had designs on some of their old possessions on his eastern frontier. Philip managed to outwit the Athenians and make himself master of the disputed territory. Not long afterwards he found an opportunity for interfering in the internal squabbles of the Greeks, and fought his way down to Thermopylæ. Here a strong body of Athenians opposed him, and he retired again to his own country. It was now that Demosthenes, the greatest orator in Athens, and one of the greatest that history tells of, perceived the ambitious designs of Philip, and began to denounce him as the enemy of the liberties of Greece, and to urge not only Athens but all the Greek states to put forth their energies in a united effort to oppose him. These orations of Demosthenes have been preserved to us, and are known as "Philippics." But his warnings were not heeded, and Philip was allowed to march into Greece with a large army, with which he put an end to the *sacred war* which had for some time been raging between the Phocians and most of the other states. Philip drove the Phocians out of Delphi, which they had seized, and their votes in the Amphictryonic Council were transferred to him. He thus acquired a right to have a voice in the internal affairs of Greece, and to interfere in all questions concerning the temple of Apollo at Delphi. He and his friends in Greece—for he had secret friends in every state, even in Athens—soon found an opportunity for his interference. He marched south again, professedly against a small state that had committed some real or fictitious offence, but instead of punishing the offending state he seized Elateia, a town within easy reach of Athens. Consternation reigned in this latter city. Demosthenes, whose warnings were too late believed in, urged the people to ally themselves with Thebes and fight Philip. They did so, but were utterly defeated by him at Chœronēa (B.C. 338). He granted most generous terms of peace to the Athenians, but very harsh terms to th Thebans. He was now within sight of the great project which had long filled his mind—the invasion of Persia. Summoning a council of Greek states at Corinth, he easily got them to declare war on Persia. He then returned to his own dominions to prepare his invading expedition, but was assassinated by a young noble while walking in a grand public procession to celebrate the occasion of his daughter's marriage, B.C. 336. Philip was succeeded by his son Alexander, surnamed "the Great."

Macedonia.

Philip.

GREEK WARRIORS.

Demosthenes.

Alexander was only twenty years of age when he was called to rule the Macedonians. But he had already held important positions. At sixteen he was left by his father regent of Macedonia during Philip's absence on an expedition; and at eighteen he had an important military command. He had also had the best education the times could afford. His tutors had filled his mind with the grand poetry of Homer, and above all his intellect had been drawn out and trained by Aristotle,

Alexander the Great, B.C. 336.

the greatest logician of old, or perhaps of any time.

Philip left everything almost ready for his intended invasion of Persia. The army was the most formidable in the world at the time, though in mere numbers quite insignificant as compared with that of Persia. But the Macedonian "phalanx" was irresistible. It consisted of foot-soldiers armed with very long spears—twenty-one feet long—standing in ranks one behind the other. The spears of the first five ranks projected in front of the whole body, making a hedge of spears, which it was almost impossible to break through with the short spears and swords then used by the Greeks and other nations.

His army.

Alexander's first move was to march into Greece to put down signs of independence which the states were disposed to assert when they heard of Philip's death. Thebes having openly defied him, he took the city, slew the garrison, sold the inhabitants into slavery, and razed the city to the ground. This terrible example struck terror into the other states, and they gave him no further trouble.

In the spring of B.C. 334 he led his little army of 35,000 men across the Hellespont to conquer Persia, whose monarch could bring nearly a million men to meet him. The first battle was fought at Granikus, and won, after a hard struggle, by the invaders. A second great battle was soon fought at Issus. Here Darius, the Persian king, commanded in person an immense army, estimated at over half a million. But Darius had to fly from the field, leaving his camp and baggage behind. Even his family fell into the conqueror's hands, and were honourably treated by him.

Invasion of Asia.

Alexander now determined to subdue the Persian provinces of Phœnicia and Egypt, so as to cut off the maritime supports of Darius. He accomplished these conquests, after a desperate resistance from Tyre. Egypt did not oppose him, and he founded at the mouth of the Nile the city of Alexandria, which afterwards became the principal seat of learning in the world, and to this day is an important city.

Conquest of Egypt.

Crossing the Euphrates in pursuit of Darius, Alexander came up with the Persian monarch at Arbela, not far from Nineveh, and gained another great victory (B.C. 331). Darius fled, and his conqueror entered in triumph into Babylon, where he soon made himself popular. He was now complete master of Persia, no army daring to meet him. He pursued Darius for some time, and just as he was about to capture him, a Persian noble, to prevent the disgrace of his master, killed Darius with his own hand. Pursuing his eastward course, Alexander founded the places now known as Herat, Candahar, and Cabul. He subdued Afghanistan and Bokhara, and eventually crossed the Indus into Hindostan, and got as far as the river Sutlej. But though his ambition was still unsatisfied, he had now to turn, simply because his army would go no farther. Retracing his steps to the Indus, he followed its course to the Indian Ocean. He then directed his admiral, Nearchus, to explore the coasts in the Persian Gulf, and especially the mouths of the Tigris and Euphrates, with a view to future trading. He with his army marched back through burning deserts to Susa, and commenced at last to take measures for the consolidation of his immense new empire and the social improvement of his subjects. But before he had made much progress in his plans, he caught a fever, which, aggravated by his intemperate habits, carried him off at the early age of thirty-two (B.C. 323).

Battle of Arbela.

Death of Darius.

Invasion of India.

Death of Alexander, B.C. 323.

After the death of Alexander, his generals divided his empire among them, and erected monarchies, the chief of which were Macedonia, Asia, and Egypt. Macedonia, after passing through many changes, became a Roman province in B.C. 146. The Asiatic provinces were likewise absorbed into the Roman empire in B.C. 63; and finally Egypt shared the same fate on the death of Cleopatra, in B.C. 30 The Greek states never recovered from the Macedonian conquest; and in B.C. 146 the Romans finally overran Greece, and it became thenceforth a Roman province, and has never been independent until our own times.

Break-up of his empire.

Fate of Greece.

But Alexander's conquests did produce very important effects. They opened up new fields to the influence of Greek culture, and the language and civilisation of Greece spread far and wide over Asia and Egypt. With the absorption of Greece into the kingdom of Macedonia, and the consequent extinction of her political influence, we may close the history of Ancient Greece. Thenceforth her influence on the world, though perhaps greater and more beneficial than ever, was to be exercised through her literature and art, not through her fleets and armies.

We have not had space to watch the progress of art and literature and study their effects on the people. But to understand the Greeks it is absolutely necessary to see and know what they have done in this, the field of their noblest and most lasting achievements. Their tragedians—Æschylus, Sophocles, and Euripides; their comedian, Aristophanes; their historians, Thucydides and Xenophon; their philosophers, Socrates, Plato, and Aristotle; besides a host of others, have left writings which have survived to our own times, and which, for their genius and profundity, have never been and can hardly ever be surpassed.

Art and literature of Greece.

Their art, too, so far as it was expressed in enduring material, has served ever since as the model for Europe, and even now we can hardly approach them in architecture and sculpture. In the British Museum, shorn indeed of the beautiful surroundings in which the Greeks saw them, chipped, stained, and weather-beaten, but still sublime, we can gaze on the works of artists whose bones were dust centuries before one stone was laid upon another in this our ancient city of London.

X.

GREECE.

Greece is a maritime country in the south-east of Europe, having on the north European Turkey; west, the Ionian Sea; south, the Mediterranean; and east, the Ægean Sea or Archipelago. It lies between lat. 36° 10′ and 39° 54′ N., and long. 19° 36′ and 26° 16′ E. Area, 20,017 square miles; population (1879), 1,679,775. In addition to this, Greece has, in accordance with the convention of 24th May, 1881, acquired from Turkey parts of Thessaly and Epirus, to the amount of 5160 square miles and 388,000 inhabitants. Greece consists of a continental portion and numerous islands, the largest of which is Eubœa or Negropont, more than 100 miles in length. The continental portion is nearly divided into two parts by the gulfs of Patras and Lepanto on the west, and the gulf of Ægina on the east; the isthmus of Corinth, which connects them, being, where narrowest, only about six miles across. The northern portion is Hellas, or Greece proper; the southern the Morea, or Peloponnesus. The coasts are deeply indented, irregular, and elevated, and the surface is almost entirely occupied by mountains and valleys. The principal mountain chain is the Pindus, which extends from north-west to south-east, through Hellas to the isthmus of Corinth, and has as its loftiest summit Mount Guiona, 8240 feet in height. The country is watered by numerous streams, but they are mostly short, rapid, and unfit for navigation. There are numerous lakes, but they are all small, the largest being Lake Topolias. The climate is mild and agreeable, and for the most part healthy, except in the vicinity of lakes or low marshy tracts. Mountains, rivers and lakes occupy more than one-third of the area of the country, and probably not more than two-fifths are capable of cultivation. The forests are considerable. The principal grain crops are wheat, maize, barley, rye, and oats. The principal fruit trees are the olive, vine, orange, lemon, fig, almond, citron, pomegranate, and currant-grape. Mulberry trees for silk cultivation are common. Tobacco is also grown. Agriculture, however, is in a very backward state. The manufactures are very inconsiderable, and are mostly domestic. They comprise woollens, cottons, silks, coarse pottery, leather, soap, and cutlery. The Greeks on the sea-coast and islands are largely employed as fishermen, seamen, and traders. Ship-building is also extensively carried on. Little is done to develop the mineral resources of the country. Iron and coal are found, and excellent marble. The chief exports are currants, figs, and other fruits; tobacco, wine, olive oil, honey, wax, gum, silk; the imports colonial produce and manufactured articles. Value of exports £3,559,000; imports £5,820,000. The chief town, Athens, has 63,374 inhabitants. The executive power is vested in the king, the legislative in a single chamber of deputies, 186 in number, elected directly by the people for four years. The inhabitants are mostly descendants of the ancient Greeks, and their language closely resembles the old Greek tongue. The majority belong to the Orthodox Greek Church. Education is still in a very backward state, but strenuous efforts are being made to improve it. The army consists of 894 officers and 11,911 men, and the fleet of 15 vessels carrying 69 guns and having 1480 men. The revenue for 1881 is estimated at £1,962,000, and the expenditure at £4,966,000; the public debt being £19,616,292.

TURKEY, Etc.

Turkey in Europe is a large country in the south-east of Europe, formerly much more extensive than it is at present. Previous to 1878 it had an area estimated at 138,264 square miles, and 8,315,000 inhabitants; but by the treaty of Berlin, in that year, Bulgaria and Eastern Roumelia were formed into self-governing tributary principalities; Bosnia and Herzegovina were handed over to Austria to be occupied and administered for an indefinite period, and Roumania, Servia, and Montenegro acquired additional territories and became independent states. In 1881 parts of Thessaly and Epirus were ceded to Greece. European Turkey therefore now consists of (1) Turkey Proper, comprising those provinces still directly under the rule of the Porte; (2) the self-governing tributary states of Bulgaria and Eastern Roumelia; and (3) Bosnia and Herzegovina, occupied and administered by Austria. This territory is traversed in various directions by mountain chains, generally of no great elevation, but forming numerous valleys and table-lands. Running nearly parallel to but at some distance from the west coast is a continuation of the Julian Alps, which passes through the country and enters Greece. The northern portion is the Dinaric Alps, the southern the Pindus range. The loftiest summits rise to the height of 8000 or 9000 feet. The Balkan range traverses the country from west to east, separating the basin of the Danube from that of the Archipelago. It has a general elevation of from 4000 to 5000 feet, and some of its summits are over 9000. Branching off from this southward are the Little Balkan and the Despoto Dagh ranges. The rivers are numerous, but are mostly of small size, the principal being the Danube with its affluent the Morava, and the Maritza, which falls into the Archipelago. There are numerous lakes, but they are all of small size. Turkey possesses numerous islands in the Archipelago, as well as the large island of Candia or Crete, in the Mediterranean, which is 160 miles in length by 36 in breadth. The climate of Turkey varies considerably in different parts, but in general it is much colder than that of Italy or Spain under the same latitudes. In the north the country is covered with snow and ice for several months in winter, while in the sheltered valleys of the south and west

winter is scarcely known, and the climate is delicious. In the maritime lowlands, however, the heat is sometimes excessive. A great part of the surface is covered with forests of oak, elm, pine, fir, etc. The olive is cultivated more especially in the maritime districts, and the vine is found almost everywhere. Among the other fruits are oranges, figs, citrons, lemons, pomegranates, etc. Only a small portion of the surface is cultivated, and agriculture is conducted in a very rude way; but still the country yields a considerable quantity of grain for exportation. The principal grain crop is maize, but wheat, rye, barley, oats are generally cultivated, and rice is produced in the marshy districts of the south. Flax, hemp, cotton, and tobacco are among the other products. Cattle, sheep, goats, and swine are everywhere abundant. The horse is small, but active. Iron, copper, lead, coal, salt, etc., are found, but mining is almost entirely neglected. The manufactures are mostly domestic, but some of them are celebrated—as carpets, leather, silk, and embroidery. The others include cotton, woollen and silk stuffs; cutlery, firearms, gunpowder, and saddlery. The chief exports are grain, fruits, wine, tobacco, wool, carpets, leather, cotton.

SPANIARDS.

TURKEY PROPER has on the north Montenegro, Bosnia and Herzegovina, Servia, Bulgaria, and Eastern Roumelia; and on the south Greece and the Grecian Archipelago; west, the Adriatic Sea, and east, the Black Sea and Sea of Marmora. Area, 62,030 square miles, and population 4,400,000. The capital, Constantinople, has about 600,000 inhabitants. The sultan is vested with absolute power, but must govern according to the principles laid down in the Koran. Under him are the grand vizier or head of the temporal government, and the Sheik-ul-Islam or head of the church. The former is president of the Divan or ministerial council. The revenue is estimated at about £12,000,000, and the expenditure at not less than £16,000,000 annually. The public debt in 1874 amounted to £184,981,783. The regular army numbers about 140,000 men, capable of being raised to 610,000 in war. Turkey has in Asia an area of 710,320 square miles, and 15,715,000 inhabitants; and in Africa (including Egypt) 1,552,000 square miles, and 18,410,000 inhabitants.

BULGARIA, a self-governing tributary principality of Turkey, extends from the Danube on the north to the principal range of the Balkans on the south; and from Servia on the west to the Black Sea on the east. Area 24,360 square miles; population 1,995,701. Chief town, Sofia, with 20,541 inhabitants. The soil is generally fertile, and large quantities of wheat and other grain are grown and exported. Attention is also given to the rearing of cattle and sheep. The chief exports are grain, wool, skins, and timber. It is governed by a prince and a national assembly consisting of a single chamber, the members of which are chosen directly by the people. The great majority of the people belong to the Oriental Greek Church, and speak the Servian language. In time of war the army may be raised to 80,000 men. The sovereignty of the sultan is acknowledged by the payment of an annual tribute.

EASTERN ROUMELIA has Bulgaria on the north, Turkey Proper on the west and south, and the Black Sea on the east. It has an area of 13,500 square miles, and a population of 815,500. The capital is Philippopolis. It is self-governing, having a governor-general and a legislative assembly of one chamber.

BOSNIA AND HERZEGOVINA, at present occupied and administered by Austria, formerly formed the most north-western province, or eyalet, of European Turkey. This territory is bounded on the north and west by the Austrian provinces of Slavonia, Croatia, and Dalmatia; south by Montenegro, and east by Turkey Proper and Servia. Area 24,247 square miles; population 1,142,147. The chief town is Bosna-Serai, with 21,000 inhabitants. The surface generally is mountainous, and the slopes of the mountains are for the most part densely covered with forests of oak, beech, pine, lime, chestnut, etc. The valleys are well watered and fertile, producing grain and fruits in great abundance. Sheep, goats, and swine are numerous. The country is said to abound in minerals, but as yet they are neglected. The manufactures are unimportant, the principal being coarse cutlery and firearms, woollen goods, leather, and ropes. The chief exports are agricultural products, fruit, timber, cattle, hides, wool; the imports colonial goods, cloth, cotton, salt, etc. The inhabitants are mostly Servians.

MONTENEGRO is a small independent principality lying immediately south of Bosnia and

Herzegovina, and having on the other sides Dalmatia, the Adriatic, and Turkey Proper. It has an area of about 2330 square miles, and a population of 236,000. The surface is mountainous, and largely covered with forests. The chief products are maize and other grain, fruits and potatoes. The only manufacture of importance is coarse woollens. The principal exports are sheep and goats, wool, cheese, fish, smoked mutton, fruits, wine, hides, and sumac. There is no standing army except the prince's body-guard, but the whole male population are trained to arms. The executive power is vested in the prince, and the legislative in a senate. The capital is Cetigne, with 2000 inhabitants.

SERVIA, which has lately assumed the title of kingdom, is bounded on the north by the Danube, which separates it from Hungary; west by Bosnia, south by Turkey Proper, and east by Bulgaria and Roumania. Area 18,781 square miles; population (1880), 1,700,211. Capital, Belgrade, with 26,970 inhabitants. The surface of the country is mountainous, with extensive forests and large tracts of uncultivated heath. The valleys are fertile, yielding good crops of grain and other products. The mineral wealth is considerable, but undeveloped. The principal exports are wood, grain, and cattle. The annual value of the exports is about £1,400,000; imports, £1,250,000. The executive power is vested in the king and his responsible ministers, and the legislative in the king and the *Skuptschina* or parliament, of which 40 members are chosen by the government and 128 by the people. The permanent army numbers about 50,000 men, capable of being raised in war to 265,000. The revenue for 1880 is estimated at £1,027,000: the expenditure at £1,027,580, the national debt being over £4,000,000.

ROUMANIA is a kingdom formed out of the provinces of Moldavia and Wallachia and the territory of the Dobrudscha, having on the north and north-west Transylvania, from which it is separated by the Carpathian mountains; north-east, Russia; east, the Black Sea; south, Bulgaria; and west, Servia. The Danube forms the boundary on the west and south, except in the Dobrudscha. Area 50,360 square miles, and population 5,376,000. The capital is Bucharest, with 177,646 inhabitants. The country is for the most part a great plain, rising gradually to the Carparthians in the north. The rivers are all tributaries of the Danube, the principal being the Pruth, Sereth, and Aluta. The soil is generally fertile, but the crops suffer much from extreme droughts in summer. The climate is characterised by extreme heat in summer and intense cold in winter. The principal crops are maize, wheat, barley, and rye; vines and fruits of various kinds are abundant. The rearing of cattle, sheep, and horses is largely carried on. The exports are chiefly grain and cattle. In 1880 the exports amounted to £8,756,755, and the imports to £10,213,456. The executive is vested in the king and his ministers; the legislative in the king and the National Assembly, composed of a senate of 70 and a chamber of deputies of 145 members. The permanent army in peace numbers about 30,000 men, capable of being raised during war to 150,000. The revenue and expenditure for 1881 were each estimated at £4,830,000; the national debt being upwards of £22,000,000.

ITALIANS.

ALGEBRA.

By WILLIAM B. CLARK.

I.

INTRODUCTION.

ALGEBRA is a method of reasoning about numbers by means of certain symbols, of which there are two kinds—*symbols of quantity*, and *symbols of operation*. These are placed here for convenience of reference; and the student

of arithmetic has probably already made himself familiar with most of the symbols of operation.

The symbols of quantity are (1) the letters of the alphabet, which stand for numbers, and (2) the ordinary numbers of arithmetic. It is customary to indicate *known numbers* by the first letters of the alphabet, *a*, *b*, *c*, etc., and *unknown numbers* by the last letters, *x*, *y*, *z*.

The symbols of operation are certain conventional marks or *signs*, which are used to indicate the operations to be performed on the symbols of quantity. Of these the most important are the following :—

+, read *plus*, signifies that the quantity to which it is prefixed is to be added. Thus $a + b$ signifies that the quantity b is to be added to the quantity a. If a stand for 3 and b for 5, then $a + b$ will be 8.

Quantities which have + before them are called *positive* quantities.

—, read *minus*, signifies that the quantity to which it is prefixed is to be subtracted. Thus $a - b$ signifies that b is to be subtracted from a. If a is 6 and b 4, then $a - b$ is 2.

Quantities which have — before them are called *negative* quantities.

When no sign stands before a quantity, + is understood.

×, read *into*, signifies that the quantities between which it stands are to be multiplied together. Thus $a \times b$ signifies that a and b are to be multiplied together. This sign is generally omitted between simple quantities. Thus ab is the same as $a \times b$; $4a$ is the same as $4 \times a$. A point between the quantities has the same meaning. Thus $a \,.\, b$ is the same as $a \times b$ or ab.

÷, read *divided by* or simply *by*, signifies that the quantity which stands before it is to be divided by the quantity which stands after it. Thus $a \div b$ means that a is to be divided by b.

Division, however, is more frequently expressed by writing the quantity to be divided over the quantity which is to divide it with a horizontal line between them. The two quantities thus written form, as the student already knows from his arithmetic, a *fraction*, of which the quantity above the line is called the *numerator*, and the quantity below the line the *denominator*. $\frac{a}{b}$ is the same as $a \div b$: a is the numerator, and b the denominator.

=, read *equals*, signifies that the quantities between which it stands are equal to each other. Thus $a = b$ means that a is equal to b. $ax - by = cd$ means that the quantity $ax - by$ is equal to the quantity cd.

$>$ or $<$, the symbols of inequality, indicate that the quantity towards which the open end stands is greater than the other.

$\therefore$ means *therefore*.

$\because$ means *because*.

( ), called *brackets*, indicate that the quantities which stand within them are to be treated as one quantity. Thus $a - (c + d)$ means that we are to add c and d together, and subtract the whole from a. $(a - c)b$ means that c is to be subtracted from a and the remainder is to be multiplied by b. A line drawn over several quantities means the same as enclosing these quantities in brackets. Thus $a - \overline{c + d}$ is the same as $a - (c + d)$. There are sometimes several pairs of brackets, one within the other; and when this is the case the brackets are made of different shapes, as { }, [ ], in order to distinguish the different pairs from each other.

Besides the above symbols the ordinary technical terms of abstract arithmetic are used, and the student who desires explanations of them is referred to the articles in the UNIVERSAL INSTRUCTOR on arithmetic.

Any quantity which multiplies another is called the *coefficient* of the quantity which it multiplies. Thus, in the product ab, a is the coefficient of b, or b of a. In $4ab$, 4 is the *numerical coefficient* of ab.

When a quantity is multiplied into itself several times the result is called a *power* of the quantity; and the number of times the quantity has occurred as a factor is indicated by a number placed over the quantity at its right-hand corner. This number is called the *index* or *exponent*. When the quantity has occurred twice as a factor, the result is its second power, or square; and this is indicated by the exponent 2. When the quantity has occurred three times as factor, the result is the third power, or cube, indicated by the exponent 3; and so on. Thus $a \times a$ is a^2, read a to the second power or a squared; $a \times a \times a \times a$ is a^4, read a to the fourth power. When n a's are multiplied together the result is a to the n^{th} power, or a^n.

The converse of *power* is *root*. The square root, or second root of a given quantity, is the quantity whose second power is the given quantity. Thus a is the square root of a^2, a is the fifth root of a^5. The sign $\surd$ (a corruption of r, the initial letter of the word *radix*, which means *root*), indicates square root, $\sqrt[3]{}$ indicates cube root or third root, $\sqrt[4]{}$ indicates fourth root.

Any combination of algebraical symbols is called an *expression* or *formula*. The parts of an expression connected by the sign + or — are called *terms*. Thus a and b are the terms of the expression $a + b$. A *simple* expression consists of one term. Thus ab is a simple expression. A *compound* expression, or *multinomial*, consists of more than one term. Thus $a^2 + 2ab + b^2$ is a compound expression. An expression of two terms is called a *binomial*. An expression of three terms is a *trinomial*. Thus $a + b$ is a binomial; $a^2 + 2ab + b^2$ is a trinomial.

Quantities are said to be *like* when they differ only in their numerical coefficients. Thus $2ab$ and $4ab$ are like quantities. Quantities are *unlike* when they consist of different letters, or of the same letters with different exponents. Thus ab and a^2b are unlike. So are ab and ac. Also ab and cd.

The student may now exercise himself in computing the numerical value of the following algebraical expressions. One is worked out in full as a guide :—

If $a = 4$, $b = 6$, $c = 10$, and $d = 1$, find the value of $2a^2 + 4b^3 + c^2 + d^4$.

$a^2 = 4^2 = 4 \times 4 = 16$; $\therefore 2a^2 = 32$
$b^3 = 6^3 = 6 \times 6 \times 6 = 216$; $\therefore 4b^3 = 864$
$c^2 = 10^2 = 10 \times 10$ $\therefore c^2 = 100$
$d^4 = 1^4 = 1 \times 1 \times 1 \times 1$ $\therefore d^4 = 1$
Sum = 997,

the value required.

If $a = 8$, $b = 7$, $c = 6$, $d = 5$, and $e = 1$, find the value of $3a - 2b + 4c - e$. Ans. 33.
of $ab + ce - bd$. Ans. 27.
of $\frac{a+b}{c-e} + \frac{3b-2c}{a-d}$. Ans. 6.
of $d^2 + a - c - 3ce^2 + d^3$. Ans. 157.

If $x = 5$, $y = 7$, $z = 3$, find the value of $3x^2 + 5y^3 - 2z^3$. Ans. 1736.

Addition.

Addition is performed by writing down in one line the quantities to be added, and connecting them by their proper signs (*i.e.* the signs which indicate the operation to be performed). Thus the sum of x and y is written $x + y$; the sum of x and $-y$ is written $x - y$; the sum of $-x$ and $-y$ is written $-x - y$; the sum of $-x$ and y is written $-x + y$.

If we have to add several like quantities we may "simplify" the result. Thus, suppose we have to add $3x$ and $2x$, we may write the result $3x + 2x$; but it is obvious that $3x$ added to $2x$ is $5x$. When, therefore, like quantities, *having like signs*, are to be added, find the sum of their numerical coefficients, and prefix it to the common letter or letters, retaining the common sign. If the like quantities have *unlike signs*, find the sum of the numerical coefficients of the positive quantities, and the sum of the numerical coefficients of the negative quantities. Take the difference of these sums. The remainder is the numerical coefficient of the required sum; and the required sign is the sign of the greater sum. Thus if $3x$ be added to $-2x$, the result is x, because the difference between 3 and 2 is 1, and the positive quantity has the greater coefficient. If $-3x$ be added to $2x$, the result in this case is $-x$, because the negative quantity has the greater numerical coefficient. Similarly, add together the four quantities, $-3x$, $-2x$, $4x$, $-7x$. The sum of the numerical coefficients of the positive terms is 7; the sum of the numerical coefficients of the negative terms is 9. The sign is therefore negative. The difference of the two sums of the numerical coefficients is 2, and the result of the addition is $-2x$.

To add expressions containing like and unlike terms: Add all the like quantities as above, and put down in one line the sums connected by the proper signs. Thus to add $3x - 4y$ and $3x + 2y$. The sum of the x's is $6x$; the sum of the y's is $-2y$. The answer is $6x - 2y$. Add $3x + 4y$ and $3x - 4y$. The answer is $6x + 0$: that is $6x$.

Examples.

Add $5a - 3b$ and $4a - 7b$. Ans. $9a - 10b$.
„ $4a^2c - 10bde$, $6a^2c - 9bde$, and $11a^2c - 3bde$. Ans. $21a^2c - 22bde$.
„ $7a + 3b$ and $-5a - 9b$. Ans. $2a - 6b$.
Add $-abc + 2d^2$, $-14abc + 10d^2 - 10abc + d^2$. Ans. $-25abc + 13d^2$.
„ $4xy - z^2$, $-xy - 3z^2$, $-xy + 5z^2 + pq$, $8xy + \frac{1}{2}z^2 + pq$, $-5z^2 - 4xy - 2pq$, and $-8xy - 4z^2 + pq$. Ans. $-2xy - \frac{1}{2}z^2 + pq$.
„ $2xy - 10x^2$, $-3x^2 + xy$, and $-xy + 9x^2$. Ans. $-14x^2 + 2xy$.
„ $3ab + x - y$, $4c + 2y + x$, $5ab - 3c + d$ and $4y + x^2 - 2y$. Ans. $8ab + c + d + 2x + x^2 + 3y$.
„ $a + b - c$, $-x + 3y + 2bm$, and $z^2 - rp^2 - mz$. Ans. $a + b - c - x + 3y + 2bm + z^2 - rp^2 - mz$.

Subtraction.

If we subtract b from a, the result is written $a - b$. If we subtract $b - c$ from a, the thing to be subtracted is diminished by c; therefore the remainder is increased by c (*i.e.* the result is $a - b + c$).

Thus we see that subtraction is performed by changing the sign of the quantity to be subtracted, and then adding the quantities by the rules of addition. Thus subtract y from x, the result is $x - y$; subtract $-y$ from x, the result is $x + y$; subtract $2x$ from $3x$, the result is x; subtract $-3x$ from $2x$, the result is $5x$.

From $5x - 2y$,
subtract $2x + 5y$

The result is $3x - 7y$.

In performing subtraction it is, of course, not necessary actually to change the signs. It is enough to conceive them as changed.

Examples.

From $3a$ take $5a$. Ans. $-2a$.
„ $-2b$ take $4b$. Ans. $-6b$.
„ $-c$ take $8c$. Ans. $-9c$.
„ $5ax^2$ take $2ax^2 + 4$. Ans. $3ax^2 - 4$.
„ $5a^2 + 3bx + 14$ take $a^2 + 2bx - 10$. Ans. $4a^2 + bx + 24$.
„ $a + b$ take $a - b + c$. Ans. $2b - c$.
„ $6x^2 - 8y + 3$ take $2x^2 + 9y - 2$. Ans. $4x^2 - 17y + 5$.
„ $7x^3 - 2x + 5$ take $3x^2 + 5x - 1$. Ans. $4x^2 - 7x + 6$.
„ $5y^2 - 4y + 3a$ take $6y^2 - 4y - a$. Ans. $-y^2 + 4a$.
„ $4a - 3b + 6c - 11$ take $10x + a - 15 - 2y$. Ans. $-10x + 3a - 3b + 4 + 6c + 2y$.
„ $a^4 - b^4$ take $a^4 - a^3b$. Ans. $a^3b - b^4$.

Brackets.

Brackets indicate that the quantities which they enclose are to be treated as one whole. Thus $a + (c + d)$ means that the sum of c and d is to be added to a; $a + (c - d)$ means that the difference between c and d is to be added to a; $a - (c + d)$ means that the sum of c and d is to be subtracted from a; $a - (c - d)$ means that the difference of c and d is to be subtracted from a. The student will have no difficulty in seeing that $a + (b + c)$ is the same thing as $a + b + c$; that $a + (b - c)$ is the same as $a + b - c$. That is, when a + sign stands before brackets they may be removed; when a − sign stands before the brackets we have only to remember the rule for subtraction: change the signs and add. If $b + c$ is to be subtracted from a, we get $a - b - c$; and

therefore $a-(b+c)$ is the same as $a-b-c$. Similarly, $a-(b-c)$ is $a-b+c$. We see, then, that when a — sign stands before brackets. they may be removed *if we change the sign of each quantity within them.*

$$a-b-(b+c)=a-2b-c.$$
$$a-b-(c-b)=a-c.$$

The same considerations enable us to *introduce* brackets. We may write the expression $a+b+c$, introducing brackets, $a+(b+c)$; $a-b+c$ will become $a-(b-c)$, because, having a $-$ sign before the brackets, we must change the signs of the quantities within them; otherwise when we again removed the brackets we should get a wrong result. Sometimes several pairs of brackets are used; but the student has only to keep in mind the above rules and remove or introduce the brackets one pair at a time.

The student will have noticed by this time that algebraical addition has sometimes the effect of arithmetical subtraction. Thus, when we add $5a$ and $-3a$, we get $2a$; when we add $3a$ and $-5a$ we get $-2a$.

The student will perhaps ask himself—What is the meaning of a negative quantity standing by itself?—how is it to be interpreted into ordinary language? In general he will find that it must be interpreted to mean the opposite in some respect of the same positive quantity. Thus, if a means a gain of a pounds sterling, $-a$ means the opposite of a gain (*i.e.* a loss of a pounds sterling). If a means a loss of a pounds sterling, $-a$ means a gain. If a means a miles in an easterly direction, $-a$ means a miles in an opposite (*i.e.* a westerly) direction.

II.

Nature of Principal Structures (*continued*).

The third class of organs by which food is prepared for use in the body as fuel, consists essentially of a system of tubes, in some regions larger than in others, and having various appendages devoted to special branches of this work. Food is brought by means of the muscles to the mouth, a cavity contructed for chewing and moistening its contents; passing through the gullet it arrives at the stomach, a large bag which has in its walls *glands* devoted to manufacturing a juice to act chemically upon the food.

The food tube.

Stomach with glands.

The remainder of the food-tube, the *intestine*, is variously modified at different parts, for completing the work of preparing or digesting the food, and for taking it into the system so as to be available for distribution over the body. The intestine is abundantly supplied with glands which pour out valuable juices; and it is able by the regular action of the "tube-muscles" to pass the food on from place to place in it.

Intestine with glands.

Two large glands in particular pour fluids into the intestine: the *pancreas* or sweetbread, and the *liver*. The juice of the latter, called *bile*, is partly destined for removal from the body, as well as to aid in digestion. All these glands possess little bodies called gland-cells, of peculiar qualities in each gland; in these the vital activity is especially present, and they manufacture the digestive juices we have named.

Pancreas, liver, bile.

For the distribution of the prepared food in a liquid state a system of tubes permeates every part of the body, by which a constant *circulation* (4) can be kept up. These tubes are of various sizes and construction, and are connected with a central pumping organ, the *heart*. This is muscular, and contains cavities which act as blood-receivers, and which are alternately diminished and enlarged by the contraction of the muscular fibres. It is in this way that blood is continually received into and driven out of the heart.

Tubes for blood circulation.

The *lungs* (5) are organs constructed to take in regularly a considerable quantity of air containing oxygen. This enters into the blood, being an essential part of the bodily food, necessary to keep up the combustion we have described. At the same time carbonic acid and watery vapour are let out from the blood into the air in the lungs. Then the impure air is expelled from the lungs and fresh air taken in.

Lungs for exchange of gases.

The *kidneys* (6) are occupied with the work of extracting from the blood *liquid* waste material; in them the blood is strained, so to speak, and the waste is allowed to escape into the bladder, to be afterwards got rid of.

Kidneys.

Every living creature is extremely dependent on its surroundings. Food comes from the outside; enemies or hostile influences may attack us externally; knowledge of what surrounds us must enter our bodies if we are to be conscious of it. Consequently we require organs which can receive impressions of various kinds, and which can give us information about them (7). We find that there are several different kinds of impressions. All over the body, in the skin, there are distributed special structures to give us news about the substances they come into contact with, or the feelings of heat and cold, or pain that they are made to suffer.

Relation to surroundings.

Need for organs of sense.

Other impressions are conveyed to us by means of the organs of special sense. The special impression of smell enters by the nose, of taste by the mouth, of light by the eyes, of sound by the ears. Each of these organs contains a peculiar set of highly sensitive cells, which are affected by every change in the impressions made upon them from outside.

The government of the body resides in the central nervous system (8). In its various parts we find minute bodies called *nerve-cells*, which are associated with the direction of every

part of our actions; if they are destroyed, the actions which they control cannot be performed. The principal divisions of it are the *brain*, seated in the head, and the *spinal cord*, enclosed in the "*vertebral column*" or backbone. To them every impression received from without is conveyed; they store up the impressions of the past, which in the consciousness become what we call memory; and they issue every order for work, and are associated with every thought—how or in what way we know not.

Nerves for communication.

For the receiving of news from the organs of sense, and the issuing of orders to the various active agencies, cords of communication are needed; these are the *nerves* (9), white cords which traverse nearly every portion of the body, transmitting unchanged what is committed to them.

Organs for continuing the species.

Lastly, to certain portions of the bodily structure is entrusted the duty of reproducing the species (10). Living cells are separated as representatives of the whole, embodying the power of reproducing every structure; and there are appropriate organs for the growth and nourishment of these young offshoots.

Structure of the Body in Different Regions.

Cross sections.

A very useful method of gaining ideas of the construction of the body is to make a series of cross-cuts through various parts of the trunk and limbs, and examine the plan of arrangement of the organs. Let us begin with a section directed across the middle of the abdomen—say about the region of the navel.

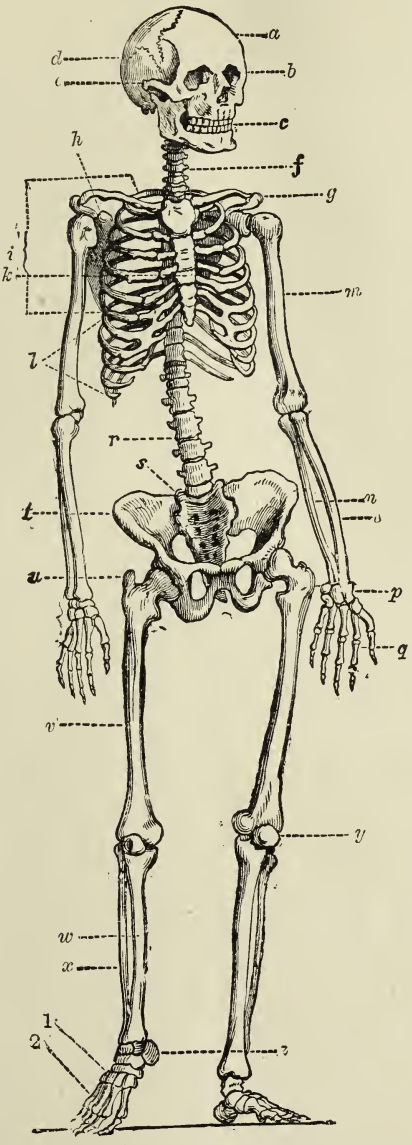


FIG. 4.—THE HUMAN SKELETON.

a, the frontal bone; *b*, the orbit; *c*, the teeth; *d*, the temporo-parietal suture; *e*, zygomatic arch; *f*, the cervical vertebræ; *g*, the shoulder girdle; *h*, the coracoid process of scapula; *i*, the six upper ribs; *k*, the sternum or breastbone; *l*, the six lower ribs; *m*, the humerus; *n*, the ulna; *o*, the radius; *p*, the carpus or wrist; *q*, the finger-bones; *r*, the lumbar vertebræ; *s*, the sacrum; *t*, the crest of the ilium; *u*, the great trochanter of the femur or thigh-bone; *v*, the shaft of the femur; *w*, the tibia or shin-bone; *x*, the fibula; *y*, the patella or knee-pan; *z*, the heel; 1, the tarsus; 2, the metatarsus.

The Lower Part of the Trunk.

We should find, just within the skin, layers of flesh, or muscle. In the middle line of the back we should cut through a bony spine which projects from the backbone; and on either side of this there is a thick mass of muscle. In front of the spinous bone we find a bony ring, about an inch and a half in diameter, the front of which is very much thicker and more massive than any other part. This is one of the bones of the spinal column, enclosing the spinal canal. In this canal we perceive a soft white cord nearly an inch in diameter; it is the spinal cord, a part of the central nervous system. From it we can see smaller cords branching off on either side, and passing outside the spinal canal through various holes.

View across abdomen.

Backbone.

Enclosing spinal cord.

In front of this spinal column we find that the muscles of the abdomen surround a very large cavity, in which the various organs lie. Occupying the greater part of the space we see a number of coils, each of which evidently encloses a tubular cavity. These are the coils of the gut or *intestine*, which are all fastened by bands to the front of the bony axis we have described. But besides this we shall have cut across a pair of red fleshy organs, the kidneys, placed at the sides of the back of the abdomen; and several gaping mouths of tubes will indicate the principal bloodvessels, immediately in front of the spine. A little higher up we should meet with a much dilated bag, the stomach; and a large reddish-yellow solid organ, the liver, with numerous open tubes of various sizes visible in the cut ends of bloodvessels.

Abdominal cavity.

Intestine.

Kidneys.

Stomach and liver.

XLV.

STUDY FOR READING AND PRONUNCIATION.

Der Paradies-vogel Schluß.[1]
dare pah-ra-deece'-fo'-gel shluss
THE BIRD OF PARADISE—CONCLUSION.

Dieſer Vogel hat ein ungemein ſcharfes
dee'-zer fo'-gel hat ine un'-ge-mein sharf'-es
This bird has exceedingly acute

Gehör. Sobald er ein Geräuſch[2] hört,
ge-hoer' zo-balt airr ine ge-roish' hoert
hearing. So soon (as) he a rustling hears,

ſchweigt er ſtill, und verſteckt[3] ſich im
shvycht airr still unt fer-stekt' sich im
becomes he silent and hides himself in the

Laube; dauert das Geräuſch fort, ſo
low'-be dow'-ert dass ge-roish' fort zo
foliage; continues the rustling on, so

fliegt er davon.[4] Sie ſuchen die
fleecht airr dah'-fon zee zooch'-en dee
flies he away. They seek the

etwas fleiſchigen Kapſeln des Teak-
ett'-vas fly'-shee-chen kap'-seln dess teck'-
somewhat fleshy catkins of the teak-

baumes, vorzüglich[5] aber die
bow-mes for-tsuech'-lich ah'-ber dee
tree, pre-eminently however the

roſenrothen und ſchleimigen Feigen. Man
ro'-zen-ro'-ten unt shly'-mich-en fy'-gen man
rose-red (pink) and slimy figs. One

fand aber auch ſchon Inſekten in
fand ah'-ber ouch shone in-sek'-ten in
found however also already insects in

ihrem Magen, und auf Amboina wurden
eer'-en mah'-gen unt owff am-boy'-na voor'-den
their stomachs, and on Amboyne were

zwei mit gekochtem[6] Reis und Gemüſe
tsvy mit ge-koch'-tem rice unt ge-mueh'-ze
two with boiled rice and vegetables

ernährt.
er-nayrt'
nourished.

Die Papus fangen dieſe Vögel mit
dee pah'-poos fang'-en dee'-ze foh'-gel mit
The Papus catch these birds with

Leim vom Brodbaume; gewöhnlich
lime fom broht'-bow-me ge-vohn'-lich
(bird) lime from the bread-tree; generally

klettern[7] aber jene Nachts
klet'-tern ah'-ber yay'-ne nachts
climb however those (people) at night

auf die Bäume, wo ſie ſchlafen, warten[8]
owff dee boy'-me vo zee shlah'-fen varr'-ten
on the trees, where they sleep, wait

die Dämmerung[9] ab und ſchießen ſie
dee dem'-mer-ung ap unt shee'-sen zee
for the dawn and shoot them

dann mit Pfeilen, reißen ihnen, um
dann mit pfy'-len rice'-sen ee'-nen um
then with arrows, tear them, in order

ſie beſſer verpacken[10] zu können, die
zee bes'-ser fer-pack'-en tsoo kön-nen dee
them better to pack to be able, the

Füße aus, entfernen[11] das Fleiſch und
fues'-se ouss, ent-fairr'-nen dass flysh unt
feet off, remove the flesh and

bisweilen[12] die Flügel, ſtecken ein Stück
biss'-vy'-len dee flue'-gel steck'-en ine stueck
sometimes the wings, stick a bit (of)

Holz[13] durch, trocknen ſie am Feuer
hollts dooreh troc'k'-nen zee am foy'-err
wood through, dry them at the fire

in Bambusrohr[14] und verkaufen ſie an
in bam'-bus-roar unt fer-kow'-fen zee an
in bamboo cane and sell them to

die Malayen, welche dieſelben nach
dee mah-lah'-yen vel'-che dee-zel'-ben nach
the Malays, who the same to

den Molucken ſchaffen,[15] und von da
dane moh-luck'-en shaff'-en unt fon dah
the Moluccas despatch, and from thence

nach China, Indien und Europa.
nach chee'-nah in'-di-en unt oy-roh'-pah
to China, India and Europe.

Hier werden ſie zu Federbüſchen
heerr vairr'-den zee tsoo fay'-der-buesh'-en
Here are they for plumes

verwendet,[16] welche jedoch nur auf
fer-ven'-det vel'-che yay'-doch noor owff
used, which however only on

Baretten gut ſtehen,[17] nicht im bloßen[18]
bah-ret'-ten goot stay'-en nicht im blow'-sen
flat caps well suit, not in plain

Haare. Der Goldglanz ſolcher Büſche
haa'-re dare gold'-glantz zol'-cher buesh'-e
hair. The golden sheen of such plumes

verbleicht[19] aber ſehr leicht in der Sonne
fer-blycht' ah'-ber zayr lycht in dare zon'-ne
pales however very easily in the sun,

und ſelbſt beim Kerzenlichte.[20] Sie
unt zelbst byme kerr'-tsen-lich'-te zee
and even by candle light. They

zieren ſeit undenklichen[21] Zeiten die
tsee'-ren zyte un-denk'-lich-en tsy-ten dee
ornament since immemorial times the

Turbane der indiſchen Sultane und
toorr-bah'-ne dare in'-dish-en sul-tah'-ne unt
turbans of the Indian sultans and

die Dolche der malayiſchen Radſchahs.
dee dol'-che dare mah-lah'-yish-en rad'-shahs
the daggers of the Malay rajahs.

REMARKS ON THE FOREGOING STUDY.

[1] *Der Schluss*, the conclusion; from the verb *schliessen, schlosz, geschloszen*, to close or lock. Hence *der Schlüssel*, the key.

[2] Remark the prefix *ge*—as meaning a number, collection, or continuance, equivalent to the English termination *ing*. *Rauschen*, to rush or rustle; *das Geräusch*, the rustling: *murmeln*, to murmur; *das Gemurmel*, the murmuring: *sprechen*, to speak; *das Gespräch*, the conversation or dialogue.

[3] *Verstecken*, to hide; *er versteckt sich* (literally, he sticks himself away).

[4] *Davon* (literally therefrom): *davon laufen*, to run away; *davon eilen*, to hurry away, etc.

[5] *Vorzüglich*, from *vorziehen*, to prefer (to draw before); hence *der Vorzug*, the advantage.

[6] *Kochen* means both to cook and to boil. We say *kochendes Wasser*, boiling water. Another expression for the verb to boil is *Sieden* (seething wells).

[7] *Klettern* is the usual expression for the verb to climb; *klimmen, klomm, geklommen,* is likewise used; whence the old form of the past, "clomb."

[8] *Warten,* to wait; *abwarten,* to wait for (literally to wait off, to wait till a thing comes off or happens). In the same way *gewinnen,* to win; *abgewinnen,* to win from, or off.

[9] *Die Dämmerung* originally means the twilight; and thus we speak of *die Morgendämmerung,* the morning dawn, or twilight; and *die Abenddämmerung,* the evening twilight.

[10] *Packen,* to pack; *verpacken,* to pack up.

[11] *Entfernen,* to remove (literally to put to a distance; from *fern,* far).

[12] *Bisweilen,* from *weile,* while; like the Scottish expression "whiles (sometimes), he did it."

[13] Where a certain quantity is designated the English word *of* is not expressed in German. Thus we say *ein Buch Papier,* a quire *of* paper; *ein Flasche Wein,* a bottle *of* wine; *drei Pfund Rosinen,* three pounds *of* raisins, etc.

[14] *Bambus-rohr.* The word *Rohr* originally means reed or cane; it is also applied in the form *Röhre* to a pipe: *die Luftröhre,* the windpipe.

[15] *Schaffen* has various meanings; the most general is to be busy, from whence *das Geschäft,* the business; *der Mann musz wirken und schaffen, das Glück zu erraffen,* the man must work and be busy (bustle) to catch fortune.

[16] *Verwenden,* to use, to employ; from *wenden,* to turn (literally to turn to account).

[17] *Stehen,* to stand, here has the meaning to suit. *Wie schön der Kuh das Band zu Halse steht,* how well to the cow the band on the neck suits.—Schiller's *Wilhelm Tell.*

[18] *Blosz* is literally bare, naked; *mit bloszen Füszen,* with naked feet.

[19] *Bleichen,* to bleach; *verbleichen,* to turn white or bleached.

[20] *Die Kerze* means the taper; for candle the ordinary word is *Licht,* light—as *ein Wachslicht, ein Talglicht,* a wax candle, a tallow candle.

[21] *Undenklich,* literally unthinkable; from *un,* and *denken,* to think.

Exercise on the Foregoing Study.

For Translation into German, to be afterwards compared with the German Version given below, for Correction. (Notice the use of werden *for the passive form of the verb.)*

This bird is silent when he hears a rustling; he conceals himself hurriedly in the foliage, and flies away if the rustling continues. The pink and slimy figs, and the catkins of the teak-tree, are his dearest food. Sometimes he also eats insects; and it is possible to feed birds of Paradise with boiled rice and other food of the same kind.

The Papus, or inhabitants of the island (of) Papua, catch these birds for the sake of the beautiful feathers. Sometimes they use glue (Leim) from the bread-tree; but they sometimes shoot the birds with arrows at the time of the morning dawn. They tear (to) the birds' (the) feet off, and remove the flesh and sometimes the wings. The birds are then dried by the fire and sold to the Malays. These Malays despatch them to the Moluccas, from whence they are brought to China, India, and Europe. Many fables were told in old times about the bird of Paradise: for instance, that never more than one was found at the same time, and that he had no feet. The birds are bought in great numbers by the Indians, and many come to Europe. By the Chinese they are also valued highly, for the Chinese love everything that has a beautiful colour. Plumes are made of the feathers of the bird of Paradise, and are worn in the hat by various nations. Already in the earliest times the turbans of Indian sultans were adorned with such plumes as we can see from many old pictures, in which the sultans are depicted with such headdress(es). The Malay rajahs also use such feather-plumes to adorn their daggers. The brilliancy of these feathers does not last long; by the sun they are soon bleached; and even the light of many candles has as a consequence that they lose their beautiful colour. In this respect peacock feathers are preferred to them; for these keep their colour under all circumstances. And now we have heard much concerning the bird of Paradise, who, like many another creature, has been recognised as a mere bird, though a beautiful one, since he has been introduced more fully to the world.

German Version, for Correcting the Foregoing Exercise, and for Reading.

Dieſer Vogel ſchweigt wann er ein
dee'-zer foh'-gel shvygt vann err ine
Geraufch hört; er verſteckt ſich eilig im
ge-roish' hoert airr fer-steckt' zich i'-lich im
Laube, und fliegt davon wenn das
low'-be unt fleegt dah-fon' venn dass
Geräuſch fort dauert. Die roſenrothen
ge-roish' fort dow'-errt dee roh'-zen-roh'-ten
und ſchleimigen Feigen, und die Kapſeln
unt shly'-mi-chen fy'-gen unt dee kapp'-seln
des Teakbaumes ſind ſeine liebſte nahrung.
des teek'-boy-mes zind zy'-ne leep'-ste nah'-rung
Manchmal frißt er auch Inſekten; und
manch'-mahl frisst airr owch in-sek'-ten unt
es iſt möglich Paradiesvögel mit
ess ist moeg'-lich pah-ra-deece'-foh-gel mit
gekochtem Reis und anderem Futter
ge-koch'-tem rice unt an'-de-rem fut'-ter
derſelben Art zu ernähren.
der-zel'-ben arrt tsoo er-nay'-ren

Die Papus, oder Einwohner der
dee pah'-poos oh'-der ine'-voh-ner dare
Inſel Papua, fangen dieſe Vögel
in'-zel pah'-pu-ah fang'-en dee'-ze foh'-gel
um der Schönen Federn willen.
um dare shoe'-nen fay'-derrn vil'-len
Manchmal brauchen ſie Leim von dem
manch'-mahl brow'-chen zee lime fon dame
Brodbaume; aber ſie ſchießen bisweilen
brote'-bow-me ah-ber zee sheess'-en bis-vy'-len
die Vögel mit Pfeilen zur Zeit der
dee foh'-gel mit pfy'-len tsoor tsyte dare
Morgendämmerung. Sie reißen den
mor'-gen-dem'-me-rung zee rice'-en dane
Vögeln die Füße ab, und entfernen
foh'-gel dee fuess'-e ap unt ent-fair'-nen
das Fleiſch und manchmal die Flügel.
dass flysh unt manch'-mal dee flue-gel
Die Vögel werden dann am Feuer
dee foh'-gel vairr'-den dann am foy'-err
getrocknet, und den Malayen verkauft.
ge-trock'-net unt dane mah-lay'-en fer-kowft'
Dieſe Malayen ſchaffen ſie nach den
dee'-ze mah-lay'-en shaff'-en zee nach dane

Molucken, von wo aus sie nach China,
moh-look'-en fon vo owss zee nach chee'-nah
Indien, und Europa gebracht werden.
in'-dy-en unt oi-roh'-pah ge-bracht' vairr-den
Viele Fabeln wurden in alten Zeiten
feel'-e fah'-beln voorr'-den in all'-ten tsy'-ten
von dem Paradiesvogel erzählt; zum
fon dame pah-ra-deece'-foh-gel er-tsaylt tsoom
Beispiel, daß niemals mehr als einer
by'-speel dass nee'-mahls mairr als i'-nerr
zu derselben Zeit gefunden würde
tsoo dare-zel-ben tsyte ge-fund'-en vuerr'-de
und daß er keine Füße hätte. Die
unt dass airr ky'-ne fuess'-e het'-te dee
Vögel werden in großer Anzahl von
foeh'-gel vairr'-den in gross-er an-tsahl fon
den Indianern gekauft, und viele
dane in'-dy-ah'-nerrn ge-kowft' unt feel'-e
kommen nach Europa. Von den
kom'-men nach oi-roh'-pah fon dane
Chinesen werden sie auch hoch
chee'-nay'-zen vairr'-den zee owch hoch
geschätzt denn die Chinesen lieben
ge-shetsst denn dee chee-nay'-zen lee-ben
alles was eine schöne Farbe hat.
al'-les vas i'-ne shoch'-ne farr'-be hat
Federbüsche werden von den Federn
fay'-der-buesh'-e vairr'-den fon dane fay'-derrn
des Paradies-vogels gemacht, und
dess pah-rah-deece'-foh-gels ge-macht' unt
werden von verschiedenen Nationen
vairr'-den fon fer-shee'-den-en nah-tsi-oh'-nen
auf dem Hute getragen. Schon in den
owff dame hoo'-te ge-trah'-gen shone in dane
frühesten Zeiten wurden die Turbane
fruch'-es-ten tsy'-ten voorr'-den dee toor'-bah-ne
der Indischen Sultane mit solchen
dare in'-dish-en sool'-tah-ne mit zol-chen
Federbüschen geziert, wie wir aus
fay'-der-buesh'-en ge-tseerrt vee veer owss
vielen alten Bildern sehen können,
feel'-en al'-ten bild'-ern zay'-en koen'-nen
in welchen die Sultane mit solchen
in vel'-chen dee zool'-tah-ne mit zol'-chen
Kopfschmuck dargestellt werden. Die
kopf'-shmook darr'-ge-stellt vairr'-den dee
Malayischen Radschahs brauchen auch
mah-lay'-ish-en rahd'-shahs brow'-chen owch
solche Federbüsche ihre Dolche zu
zol'-che fay'-der-buesh'-e ee'-re doll'-che tsoo
zieren. Der Glanz dieser Federn
tsee'-ren dare glants dee'-zer fay'-dern
dauert nicht lange; durch die Sonne
dow'-errt nieh lang'-e doorch dee zon'-ne
werden sie bald gebleicht; und selbst das
vairr'-den zee balt ge-blycht unt zelbst dass
Licht vieler Kerzen hat als Folge daß
licht feel'-er kairr'-tsen hat als foll'-ge dass
sie ihre schöne Farbe verlieren. In
zee ee'-re shoch'-ne farr'-be fer-lee'-ren in
dieser Hinsicht werden ihnen Pfauen-
dee'-zer hin'-zieht vairr'-den ee'-nen pfow'-en
federn vorgezogen; denn diese be-
fay'-dern fore'-ge-tsoh-gen denn dee'-ze be-
halten ihre Färbe unter allen Um-
halt'-en ee'-re fairr'-be un'-ter all'-en um'-
ständen. Und nun haben wir viel über
sten-den unt noon hah'-ben veerr feel ueh'-ber
den Paradies-vogel gehört, der wie
dane pah-rah-deece'-foh-gel ge-hoert dare vee
manches andere Geschöpf, als bloßer
man'-ches an'-de-re ge-shoepf alls bloss'-er
Vogel erkannt, worden ist, seitdem er
foh'-gel er-kannt' vorr'-den isst zite-dame airr
der Welt vollliger vorgestellt worden
dare velt foell'-ig-er fore'-ge-stellt voorden
(ist).
(isst)

XLIII.

Proper Motion of Stars (*continued*).

Catalogue of proper motion.

THE stars possessing the largest proper motions are given in the following list, excluding, however, one or two doubtful cases:—

Groombridge 1830, 6½th mag. A small star in Ursa Major. Proper motion = 7·1″.

61 Cygni, 5½th and 6th mag. The well-known double. Common proper motion = 5·1″.

Weisse Bessel X 1112, 8½th mag. A small star in Ursa Major, between 47 and ψ. Proper motion = 4·7″.

Weisse Bessel X 1174, 7½th mag. A small star about 7° south of the last, between 47 and ξ Ursæ Majoris. Proper motion = 4·4″.

α Centauri, 1st mag. Proper motion = 3·8″.

μ Cassiopeiæ, 6th mag. Proper motion = 3·7″.

ϵ Eridani, 4½th mag. Proper motion = 3·0″.

These eight stars are the only well authenticated ones whose proper motions exceed 3″ per annum. Of these, three have had their parallaxes carefully determined, so that their real motion can be ascertained. These are 61 Cygni, α Centauri, and μ Cassiopeiæ. These stars would appear to be moving at the respective rate of some nine, four, and ten hundred million miles per annum, or at the rate of thirty, fourteen, and thirty-three miles per second. All these are considerably greater than the supposed motion of the solar system, which is only five miles per second. The parallax of the star Groombridge 1830 has not yet been satisfactorily ascertained, but it would appear to be very small, so that this star must be moving with enormous velocity, probably from two to three hundred miles per second.

Motion in miles.

The stars which follow, all have large proper motions, though not so great as those previously given:—

34 Groombridge, 8th mag. Proper motion = 2·8″.

β Hydri, 3rd mag. Proper motion = 2·5″.

ζ Toucani, 4th mag. Proper motion = 2·3″.

α Boötis, 1st mag. Proper motion = 2·2″.

It was the apparent change in the relative place of this star which first led Halley to suspect the existence of the proper motion of the stars, for it seemed to be a degree farther north than the place assigned by the early astronomers. Yet other neighbouring stars had not changed. Cassini was soon able to prove the reality of this motion by comparing it with its neighbour η Boötis, whose position remained unchanged.

Piazzi II. 123, 6th mag. A small star about a degree north of the well-known double ν Ceti. Proper motion = 2·2″.

B A C 8083, 6½th mag. A small star in Cassiopeiæ. Proper motion = 2·1″.

Piazzi IV. 212. A well-known double star in Libræ. Mags. 6 and 8. Distance 10·3″. Common proper motion = 2·0″.

τ Ceti, 3½th mag. Proper motion = 1·9″.

σ Draconis, 5th mag. Proper motion = 1·9″. As the parallax of this star = 0·24″, its proper motion corresponds to a motion of eight times the radius of the earth per annum, or about twenty-four miles per second.

δ Pavonis, 5th mag. Proper motion = 1·8″.

ζ^1 and ζ^2 Reticuli. A wide pair of 5½th mag. stars, with a common proper motion = 1·5″.

α Canis Majoris, 1st mag. Proper motion = 1·4″.

α Canis Minoris, 1st mag. Proper motion = 1·4″.

Besides their large proper motions, there is reason to believe that both these stars are moving in orbits round large dark companions, or rather round the common centre of gravity of the system. In the case of *Sirius*, a 10th mag. companion, now distant 10·8″, has been discovered, which has been supposed to be the dark companion, only imperfectly reflecting the light of its primary. It has only moved, however, through an arc of some 30° since its discovery, so that it has not yet been found possible to decide whether this companion will account for the orbital motion of Sirius, or whether there may be other hitherto undiscovered companions. As the parallax of Sirius is about 0·25″, it follows that this known companion is about forty-four times the mean distance of the earth from its primary. This companion appears to have a period of revolution of about 50 years, at a mean distance of about 7″, so that it would indicate that the combined mass of Sirius and its satellite is about nine times as great as the mass of our sun. No such companion has as yet been discovered to *Procyon*, which exhibits similar variations in its proper motion, indicating that it also is revolving in an elliptical orbit. Procyon is probably twice as far as Sirius from us, so that a similar companion would be closer to its primary and probably much harder to see.

Orbital motion of Sirius.

γ Serpentis, 5th mag. Proper motion = 1·3″.

θ Ursæ Majoris, 3rd mag. Proper motion = 1·2″.

A Ophiuchi. A pair of 5th mag. stars with a common proper motion = 1·2″.

30 Scorpii, 8th mag. Proper motion = 1·2″.

η Cassiopeiæ, a well-known binary double star, mag. 4 and 7½, moving in an orbit of mean distance 9·83″, and period 222 years, with a common proper motion of 1·2″. Its parallax being 0·15″, it follows that it is moving in an orbit with about sixty-four times the radius of that of the earth, so that the combined mass of the two stars must be about five times as great as that of the sun, whilst the proper motion indicates that the whole system is moving in space with a velocity of twenty-four miles per second.

70 Ophiuchi. Another fine binary double star, mag. 4½ and 7, with an orbit of mean distance 4·88″, and period 80 years, the common proper motion being 1·1″. Hence as its parallax is 0·16″, the system would appear to be moving through space with a velocity of twenty miles per second, whilst revolving in an orbit thirty times as large as that of the earth's, or about equal to that of Neptune. The combined masses of the two stars would seem to be about equal to four times that of our sun.

When the proper motion of the stars comes to be critically examined, a number of cases are found which seem to indicate some physical connection between two or more widely separated stars. A most marked instance of this occurs in the case of four stars in the southern hemisphere, all contained in the previous list—namely, ζ Toucani, ϵ Eridani, ζ^1 and ζ^2 Reticuli. The two latter are quite close together, but are distant by 19·4° and 19·5° from the two others, which are in turn about 33·1° apart. All these seem now moving through space with a very large common proper motion, and at the same time slowly separating from each other, at rates nearly proportional to the distance now separating them. This would lead to the conclusion, therefore, that in the distant past, perhaps sixty thousand years ago, all four must have been close together, and forming a fine quadruple star. They thus seem to have formed parts of one common system, broken up by some unknown cause, and now steadily moving away through space. Other similar cases of apparent connection between widely separated stars are also known, five of the principal stars in Ursa Major forming an instance pointed out by Proctor.

Common proper motions.

Widely separated systems of stars.

The rate of motion of the stars shown by their proper motion does not represent their actual motion in space, but only the portion of that motion which is at right angles to the line between us and the star. Any motion of approach or recession from us would not be visible in this way. Huggins, however, has applied the spectroscope to the detection of any motion of the stars along the line of sight.

If a star is approaching us, the light-waves will be compressed or shortened by the advancing motion of the star, so that any line in its spectrum will seem to be shifted towards the violet end, and *vice versâ* if the star be receding. Hence, by comparing the spectrum of the star with that of the sun, or incandescent hydrogen, it is possible to show not only whether a star is approaching or receding from us, but to approximately determine the rate

Motion of stars in line of sight.

of its motion. This has now been done by Huggins and by Christie for a considerable number of stars. The principal results are :—

Stars approaching us, with their motion in miles per second.

α Andromeda	= 33	β Geminorum	= 26
α Ursæ Majoris	= 27	Arcturus	= 33
α Herculis	= 31	α Lyræ	= 34
α Cygni	= 43	α Pegasi	= 34

Stars receding from us.

α Persei	= 25	α Tauri	= 20
α Aurigæ	= 27	β Orionis	= 18
α Orionis	= 21	Sirius	= 20
α Geminorum	= 25	Procyon	= 24
α Leonis	= 26	α Coronæ	= 40
α Ophiuchi	= 17	ε Pegasi	= 15

It is apparent that these rates of motion are in accord with those deduced from the proper motions of the stars.

XXXVII.

The Verb (*continued*).—Theory.

I. The Predicate. — It has been shown that the predicate either stands by itself or is combined with the copula in an *attributive* verb. The predicate, dissevered from the copula, may be an adjective, a noun, an adverb, or a whole phrase ; incorporated with the copula, it is always a present participle :—

La terre est RONDE, *the earth is round,*
La terre est UNE PLANÈTE, *the earth is a planet.*
Ma terre est LÀ, *my land is there.*
Ma terre est DE BON RAPPORT, *my land is productive.*
Ma terre produit (= est PRODUISANT...), *my land produces...*

Whether isolated or combined (as in *produit*), the predicate is not always sufficient to convey a full idea of what we affirm of the subject ; it often requires to be completed. Logically speaking, all words completing the sense of the predicate are its complement. From that point of view the subject, too, is completed by all words which extend its meaning. But limiting ourselves to the grammatical side of the question, we shall now consider the complements to the predicate as combined with the copula in attributive verbs. Such complements are of three kinds—*direct*, *indirect*, and *circumstantial*.

The *circumstantial* complements of the French grammarians correspond to what in English analysis are called extensions of time, place, manner, and cause, of the predicate. Like the direct and indirect complements, these extensions are connected, in French, with simple parsing, and not referred to in analysis. They need not detain us now. But a thorough knowledge of the direct and indirect complements—better known to the ordinary student as *direct and indirect objects*—is indispensable ; without it hardly a proposition could be correctly construed or composed. Why, *e.g.*, in speaking of a woman, the phrase *je l'ai entendu gronder* should present a totally different sense from *je l'ai entendue gronder*, is evidently a matter of importance. It is one which entirely depends on a right apprehension of the complement. In the first phrase *l'* (for *la*) is the direct object of *gronder*, and the meaning is that I heard the woman *being scolded ;* in the second phrase *l'* (for *la*) is the direct object to *entendue*, and the meaning is that the woman *was scolding*, and I heard her.

a. The direct complement or object of an attributive verb is the term which receives immediately the action expressed by the verb ; in other words, the action expressed by the verb passes over it without the assistance of a preposition. It answers the question *qui* or *quoi* (*whom* or *what*) made with the verb :—

A entendre les réformateurs, il faudrait recommencer le monde (Voltaire), *to hear reformers (speak), it would be necessary to make the world over again.* [A entendre qui?—les réformateurs. Il faudrait recommencer quoi?—le monde : *to hear whom?—reformers. It would be necessary to make over again what?—the world.* Les réformateurs *is the direct object to* entendre, *and* le monde *is the direct object to* recommencer.]

A verb may have several direct objects, and, conversely, one direct object may belong to several verbs :—

Les exemples ont toujours précédé les règles et les préceptes, *examples have always preceded rules and precepts* (les *règles* et les *préceptes* direct objects to *ont précédé*). Jean-Jacques Rousseau, théoricien d'humanité, hait et méprise les hommes en pratique, *J. J. R., a theoretical philanthropist, in practice hates and despises mankind* (les hommes, *direct object to both* hait *and* méprise.)

It is only transitive verbs that may have a direct object. It often happens, however, that intransitive verbs obtain such complements when, being accidentally used with an intensive or even new acceptation, they are really turned into transitive verbs :—

Tout respire en Esther l'innocence et la paix (Racine), *everything in Esther exhales innocence and peace* (innocence *and* paix *are the direct objects to* respire, *originally intransitive verb to breathe*).

La maîtresse du logis sonna sa femme de chambre, *the mistress of the house rang (for) her maid.*

The several direct objects to a verb must be of the same nature ; they require to be either all nouns, all infinitives, or all phrases. In the case of several objective pronouns, or of objective pronouns mixed with nouns, special precautions are taken, as shown at vol. ii. p. 199. This phrase would be faulty both in French and in English : *Saint Louis aimait* la justice *et* à chanter *les louanges du Seigneur*, Louis loved justice and to sing the Lord's praises. Say *Saint Louis aimait à rendre la justice et à chanter*, etc. It would equally be wrong to say *j'apprends* à chanter *et* le dessin ; either say *j'apprends le chant et le dessin*, or *j'apprends à chanter et à dessiner.*

Certain extensions of time, place, etc. (*circumstantial complements*) assume the appearance of direct objects, but they are easily detected, as they do not stand the test of the questions *qui* or *quoi*. With them the questions assume the shape of *quand* (when)? *où* (where)? *comment* (how)? etc.

La fantasque inégale, qui, m'aimant *le matin*, souvent me hait *le soir* (Boileau), *the capricious woman who, loving me in the morning, often hates me in the evening.* Translation here is sufficient to show that *le matin* and *le soir* are not direct objects ; it will also suffice in the following phrase :—

On représente Minerve *le casque* en tête, *la lance* à la main, *le sein* couvert d'une cuirasse, et *le bras* armé de son égide. The preposition *avec* (with) is evidently

understood here, and the phrase, after *Minerve*, presents a compound extension of manner of the direct object.

Likewise appositions (in connection with such verbs as *appeler*, to call; *créer*, to create; *croire*, to believe; *déclarer*, to declare; *dire*, to say; *élire*, to elect; *faire*, to make; *laisser*, to leave; *montrer*, to show; *nommer*, to name; *reconnaître*, to acknowledge; *rendre*, to render; *savoir*, to know; *tenir*, to hold; *trouver*, to find, *penser*, to think, etc.) are sometimes mistaken for direct objects, especially when the apposition is a noun.

On l'appela *le père* du peuple, *they called him the father of the people* (*le père* forms an apposition to the direct object *le*, but is not a second direct object to *appela*).

Il m'a appelé *son cher fils*, parce que je me suis montré *homme de courage, he called me his dear son, because I showed myself a man of courage* (*son cher fils* is in apposition to the first direct object *me*, and *homme de courage* in apposition to the second direct object *me*).

When the verbs *faire*, to cause, *laisser*, to let, *voir*, to see, *entendre*, to hear, appear in connection with infinitives, they are looked upon as a sort of auxiliary verbs of mood—are incorporated, so to speak, with the infinitive; and whereas in the corresponding English two direct objects would appear, in French one only is admissible.

Vous ferez quitter l'école à ceux qui ne se conduiront pas bien, *you will make those leave the school who will not behave properly: those* is the direct object to make, and *the school* the direct object to leave. In French, however, *l'école* is the direct object to *ferez quitter*, of which *ceux*, owing to the presence of *à*, is the indirect object.

Je l'ai vu faire à Paul, *I saw Paul do it; Paul* direct object to saw, *it* direct object to do; in French *l'* (for *le*) direct object to *vu faire*, and *Paul* indirect object to the same combination. For the double meaning presented by this construction consult vol. ii. p. 344.

Remarks.—1. The personal pronouns *le, la, les*, and the relative pronoun *que*, are always direct objects to the verb which follows them.—2. It must be remembered that *du, de la, de l', des*, and *de*, are often used in the sense of partitive articles, and may therefore introduce a direct object: *tu manges du pain, elle boit de l'eau, je fume de bon tabac*, etc.—3. A verb may have as its direct object an infinitive preceded by *à* or *de*, which then have more the force of expletives than of prepositions; this fact does not destroy the nature of the complement, which still answers the query *quoi? Ils craignent* de *mourir*, they fear to die; *ils craignent quoi?—de mourir.—Vous n'apprendrez jamais* à *nager*, you will never learn to swim: *vous n'apprendrez jamais quoi?—à nager.*

b. The indirect object is the term over which the action marked by the verb passes *mediately* —that is, by the help of one of the prepositions *à, de, par*, etc. It is discovered by putting with the verb the questions *à qui? de qui? par qui?* (to, of, from, by, whom), etc., for persons, and the questions *à quoi? de quoi? par quoi?* (to, of, from, by, what) for things.

Nous songeons à nos plaisirs, *we are thinking of* (*to*) *our pleasures:* nous songeons à quoi? à nos plaisirs, *we are thinking of* (*to*) *what?—of our pleasures;* plaisirs *indirect object to* songeons.

Vous vous souvenez des bienfaits, *you remember* (*of*) *kindnesses;* vous vous souvenez de quoi?—des bienfaits.

Ils furent battus par l'ennemi, *they were beaten by the enemy*; ils furent battus par qui?—par l'ennemi.

Remarks.—1. All classes of verbs may have indirect objects.—2. As *me, te, se, nous, vous*, serve both as direct and indirect objects, the learner is often puzzled as to the government of a verb; nothing but a good dictionary can help him here. When his eye and ear have become a little more trained, he will, in most instances, overcome the difficulty by turning the pronouns into the disjunctive form. So *il veut me tuer* may be changed into *il veut tuer moi*, and *il veut me parler* into *il veut parler à moi;* this operation proves that the first *me* is a direct and the second an indirect object.—3. The personal pronouns *lui, leur, en, y*, and the relative pronoun *dont*, containing each a preposition, leave no doubt as to their character of indirect objects.—4. In phrases constructed with certain intransitive verbs there is sometimes ellipsis of the preposition; this does not alter the nature of the complement which remains an indirect one: *venez remercier un père qui vous aime* (Racine); this, rendered by two imperatives, *come and thank*, into English, offers an ellipsis in French. It stands for *venez pour remercier, remercier* forming an indirect object to *venez*. *Nous consentons que vous soyez le juge entre nous et l'incrédule* (Massillon), we consent that you be judge between us and the unbeliever: *nous consentons que = nous consentons à ce que.*

II. Points of Difference between the English and the French Possessive Pronoun.

As compared with English, French seems to avoid the use of the possessive pronouns and adjectives as much as possible.

a. Where the sense clearly indicates the owner, and the name of the object possessed refers to some part of the body, use the definite article before the possessed:—

Il mourut LE visage tourné vers l'ennemi, *he died with his face turned to the enemy.*

Fermons LES yeux (Lamennais), *let us shut our eyes.*

Le marquis, la rage dans le cœur (Voltaire), *the marquess with rage in his heart.*

J'ai mal à la tête, *my head aches.*

But say *je vois que* ma *jambe s'enfle*, for it is not evident from the context whose leg is swelling. The construction *au, à la, à l', aux*, according to gender and number, is used to indicate that a sensation is taking place in that part of the body designated by the noun: *tu as mal au cou*, thou hast a sore neck; *il souffre à l'épaule*, he has a pain in his shoulder; *nous avons mal aux dents*, we have toothache, etc.

b. In those cases where the use of the article might lead to confusion from the fact of the possessor not being easily ascertained, the possessive pronoun would nevertheless be avoided by placing before the verb a personal pronoun in the form of an indirect object referring to the possessor, and by putting the definite article before the possessed:—

La tête me tourne (Mme de Sévigné), *my head swims:* —la tête tourne à moi.

Ne vois-tu pas que la tête me brûle, que le sang me bout? *dost thou not see that my head is burning, that my blood is boiling?*

Il m'a sali la main, *he has dirtied my hand.*

With the combination *au, à la, à l', aux*, before the possessed, the direct object of the possessor would stand before the verb: *je me suis blessé à la main, je l'ai brûlé à la jambe;* this construction implies something less intense and less complete than *je me suis blessé la main, je lui ai brûlé la jambe*, which indicate serious injuries to the hand and leg.

c. To avoid an equivoque, or to indicate intensity, one would not hesitate, however, to use the possessive:—

Il m'a sali mon habit, *he has dirtied my coat;* il m'a sali *l'*habit might refer to some coat that was perhaps carried under the arm.

Le commandant phénicien, arrêtant ses yeux sur Télémaque, croyait se souvenir de l'avoir vu (Fénelon), *the Phœnician commander, fixing his eyes upon Telemachus, thought he remembered having seen him.*

Il n'est point de Romain qui ne fût glorieux de vous donner sa main (Corneille), *there is no Roman who would not be proud to give you his hand* (*in marriage*); de vous donner *la* main might have implied mere shaking of hands.

d. A further shade of meaning which requires attention is illustrated by the following

examples : *je souffre au genou* is an accidental pain in the knee ; *je souffre à mon genou* indicates a usual complaint. Likewise *j'ai ma migraine* (sick-headache), *il a son asthme*, point to habitual and periodical complaints ; and *j'ai la migraine, il a l'asthme*, to something accidental.

e. It is not an unusual practice to replace the possessive by a circumlocution ; this becomes a question of taste, and can only be attempted when one has obtained a mastery of the language. While it would be quite correct to say *Louis rappela son ambassadeur de Madrid*, there is perhaps more elegance in *Louis rappela l'ambassadeur qu'il avait à Madrid. Son étude du français lui servira un jour* (his study of French will be useful to him some day) is better rendered by *l'étude qu'il fait du français lui servira un jour.*

f. The pronouns *its* and *their*, referring to abstractions or inanimate things, are literally translated into French when both the possessor and the possessed belong to the same proposition :—

La pensée doit jeter sa lumière et laisser son impression (Marmontel), *thought should throw its light and leave its impression.*

Les coups eurent leur effet, *the blows had their effect.*

Its and *their* are likewise literally translated when they are connected with a preposition, although the possessor may not be in the same proposition :—

Paris est une ville magnifique ; tous les voyageurs admirent la beauté de ses monuments.

Quand un Parisien a quitté Paris, il rapporte tout à ses usages et à ses coutumes.

When the possessor is not the subject of the proposition, or when the possessed is not governed by a preposition, *its* and *their* are replaced by *en* before the verb and the definite article before the possessed :—

Nous nous détournâmes afin d'en voir l'effet, *we turned aside in order to see its effect.*

L'auteur d'un bienfait est celui qui en recueille le fruit le plus doux (Duclos), *the doer of a kindness is the one who gathers its sweetest fruit (the sweetest fruit thereof).*

Si les plaisirs sont doux, les suites en sont cruelles, *if pleasures are sweet their consequences are cruel.*

In speaking of persons and things personified, it is always better to use *son, sa, ses, leur, leurs*, and to avoid the construction with *en*, which does not mark so well *possession* as *relation : Rien n'épuise la terre : plus on déchire ses entrailles, plus elle est libérale*, nothing exhausts the earth ; the more we tear its (her) bowels, the more it (she) is liberal ; *On flatte toujours les rois ; on admire toutes leurs actions.*—The construction with *en* must further be avoided when its use would render the sense ambiguous : *Le commerce est comme certaines sources ; si vous voulez détourner leur cours, vous les faites tarir ;* the use of *en* here would leave us in doubt whether *commerce* or *sources* is the antecedent ; *leur* points unmistakably to *sources.—Ces plantes sont bien soignées, mais leurs fleurs ne s'épanouissent pas*, these plants are well cared for, but their flowers do not expand ; to say *mais les fleurs ne s'en épanouissent pas* would mean the flowers do not expand for all that.

g. Names of things used metaphorically of persons are replaced by personal, and not by possessive pronouns :—

Parmi tous les élèves du conservatoire, il n'y a pas de meilleure flûte que lui (*not* la sienne), *among all the pupils of the Conservatoire there is no better flute* (for *flautist*) *than he.*

Il n'y a pas au palais de plus forte tête que vous, *there is not on the bench a stronger head than yours ; que la vôtre* would point to a big, hard head.

(For special cases see next Lesson.)

XVIII.

MAGNETISM.

EVEN so far back as the days of Athenian greatness the Greeks were acquainted with the fact that a certain mineral, now known as the magnetic oxide of iron, had the property of attracting iron and steel, and had also the peculiarity of setting itself in a nearly north and south position when freely suspended. It has been suggested that the word magnet was derived from the fact that this iron ore was found in great abundance near Magnesia, a city of Lydia, in Asia Minor.

Natural magnets.

This magnetic iron ore, the molecule of which has the composition of three atoms of iron to four of oxygen, and is written symbolically by chemists as Fe_3O_4, forms what is termed a *natural* magnet. The magnets most commonly in use are, however, pieces of steel, either in the shape of a bar or a horseshoe, to which magnetic properties have been artificially imparted, and which are therefore termed *artificial* magnets.

It being a special property of both artificial and natural magnets to impart to steel properly prepared magnetic properties, it will easily be understood that the number of magnets can be indefinitely multiplied ; and an artificial magnet being more convenient than a piece of loadstone, we will commence the consideration of the subject of the properties of magnets by examining the behaviour of an ordinary steel bar magnet.

Multiplication of magnets.

Such a magnet can be purchased for a shilling at a philosophical instrument maker's, and a horseshoe magnet can be bought for a few pence at the nearest toyshop. In point of fact, provided with the latter and one or two sewing or knitting needles, the bar magnet may be dispensed with ; and although it is somewhat anticipating matters, we will, in order that our readers may be enabled to perform the experiments we are about to describe, tell them how they may convert two or three of their needles into bar magnets.

How to magnetise steel bars.

Take then one of the steel needles and lay it across the ends of the horseshoe magnet, and let it remain there for some time ; on removing it you will find that it has become a magnet. Do the same with, say two more of your steel needles (knitting needles are the most convenient), and you will be fully well equipped for the following series of experiments. In each case make a mark with a file on that end of the needle which was in contact with the end of the magnet marked S.

Simple experiments.

1. Bring one of your magnetic needles near any small iron or steel objects, and attraction will result.

2. Sprinkle some iron filings (to be had for

the asking at the locksmith's) over one of your bar magnets. The filings will adhere very firmly, and in considerable quantity, to the ends of the needle, but at and near the centre of the needle no filings will be found attached.

3. Suspend by a piece of thread a small piece of iron wire. Bring either end of a bar magnet near the iron ; the latter will be attracted.

4. Now reverse the conditions of the experiment : let the magnet be suspended, and bring the iron wire near to either end ; the magnet will now be attracted by the iron.

5. Bring near to the marked end of a suspended bar magnet the unmarked end of another magnet ; they will attract each other. Now present to the same end of the suspended needle the marked end of the needle held in the hand ; the suspended needle will be repelled.

6. Suspend a magnetic needle and allow it to come to rest ; it will set in a direction which is nearly north and south ; and if it be caused to turn from that position by any external influence, it will return to its original position when free to do so.

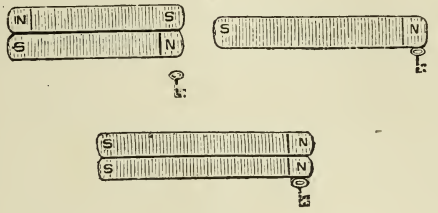


FIG. 60.

Results of the previous experiments.

Before proceeding further with our experiments, let us pause to sum up the results of the practical inquiries we have just been making.

From these, then, we see that a magnet has the property of attracting iron and steel, and that this attractive power resides principally in the ends of the magnet, which are therefore termed *poles*, and this two-endedness of a magnet is termed magnetic *polarity*. The central part of the magnet, where no attraction exists, is sometimes termed the *magnetic equator*.

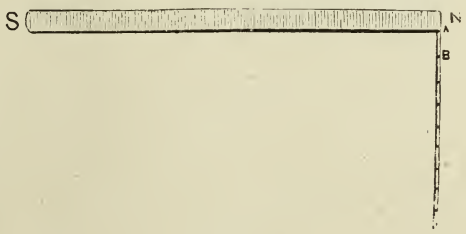


FIG. 61.

Attraction reciprocal.

The third and fourth experiments show us that the attraction between a magnet and iron or steel is *reciprocal* ; that not only does the magnet attract iron, but iron attracts the magnet.

Law of attraction and repulsion.

The fifth experiment proves to us that in magnetism, as in electricity, there is a law of attraction and repulsion, which may be thus formulated : Like poles repel, unlike attract each other.

The magnetic meridian.

The sixth experiment shows us that a freely suspended magnetic needle sets itself in a nearly north and south position. The position in which it thus remains at rest is known as the *magnetic meridian*. Further, the pole of the magnet which turns towards the north pole of the earth is termed the *north pole* of the magnet, while the end of the needle which points towards the south pole of the earth is denominated the *south pole* of the magnet. As it is believed that the reason of this "*directive*" property of the magnetic needle is that the earth itself is a great magnet, it will be obvious, from a consideration of the law of magnetic attraction and repulsion, that this nomenclature is incorrect ; and it has been suggested to substitute for the terms "north" and "south," the words "north-seeking" and "south-seeking." The former terms have, however, become so wedded to the science, that it is almost hopeless to attempt to replace them, and it must therefore be borne in mind that the north pole of the magnet is endowed with the opposite kind of magnetism to that of the north terrestrial magnetic pole, and so with the south.

Further experiments.

Having summed up the conclusions to which our experiments have so far led us, let us proceed to question nature still further, and endeavour to ascertain the manner in which the special properties of a magnet are distributed throughout its mass.

Take one of your magnetised knitting needles, and marking its north pole so as to be able to tell which end is the north and which south, break it in two. It will be found that each half has become a magnet, with its poles in the same direction as those of the original magnet. Repeat the operation upon each piece of the original magnet, and again it will be found that the fragments are perfect magnets. In this way you may break your needle into the smallest possible portions, and each piece will be in every respect a perfect magnet.

Molecular magnetism.

Now, if we follow this subdivision of a magnet in imagination to its logical conclusion, we must be impressed with the fact that the ultimate particles or "molecules" of the needle are also perfect magnets, and that the magnetic properties displayed by the needle, as a whole, are merely the sum of the magnet-

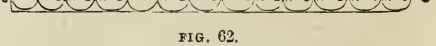


FIG. 62.

isms of its molecules. In fig. 62 an attempt is made to represent this idea in a graphic form.

A simple experiment by which this imaginary disposition of the magnetic fluids in a magnet may be to certain extent verified, is the following :—

Illustrative experiment.

Take a small piece of glass tube, and after partly filling it with steel filings, pass the pole of a strong magnet several times along the outside, being careful not to shake the tube. This will of course magnetise the steel particles, and so long as the tube is not shaken it will act as an ordinary magnet, and will have, like it, a south and a north pole. The moment, however, the tube is shaken, so as to disturb the relative position of the filings, all trace of polarity disappears.

It is of course presumed that before magnetisation the two magnetic fluids are mingled together in the molecules of a magnetic substance, and therefore neutralize each other ; this being analogous to the supposed mingling of the electric fluids in a neutral body. It must, however, be clearly understood that, as in the case of the two-fluid theory of electricity, this idea as to the existence of two magnetic fluids is purely hypothetical. The student must beware of accepting it as a proved fact. Later on in the course of these investigations of ours, we shall have to consider the origin of magnetism in another light.

Condition of neutral bodies.

A striking experiment, which illustrates the neutralisation of one pole of a magnet by the other, is the following, shown in fig. 60 on the preceding page.

Further experiments.

Take two bar magnets, and to the north pole of one of them attach any small object, such as a key. Now bring near the south pole of the other magnet ; the key will fall. On the other hand, if you place the two north poles of the magnets together it will be found that the attractive power will be much increased.

Take a bar magnet as represented in fig. 61, and suspend from one of its poles, say the north, as many pieces of soft iron wire as it will hold. What is the condition of each of these small pieces of wire during the experiment ? Obviously each one of them must act as a little magnet. For instance, the first piece of wire, A B, has its neutrality disturbed owing to the influence of the magnet which separates the two kinds of magnetism, and attracts the south, while it repels the north ; B will accordingly be a north pole, and A a south pole. This first piece of wire acts in the same way upon the second, the second upon the third, and so on. Here we have what, by analogy with electrical action, we may term magnetic *induction*. Inasmuch as the magnetism of the pieces of wire disappears the moment they are removed from the magnet, we say that they form *temporary* magnets. But not only may we have the magnetic influence exerted by contact of the magnet with a magnetic body ; we may also have this influence exerted at a distance.

Magnetic induction.

Take the north pole of a bar magnet and bring near to it a bar of soft iron. Near to, but not touching, the other end, place a freely-suspended magnetic needle. The needle will be affected in just the same way as it would have been had the needle been directly acted upon by the magnet—that is to say, its north pole will be repelled, its south pole attracted. Here we have another instance of magnetic *induction*.

In our next article we shall proceed to speak of what are known as magnetic curves, or lines of magnetic force.

II.

Anglo-Saxon Period (*continued*) : Norman Conquest.

The name of Cædmon, a Saxon monk of the convent of Whitby, is the first that occurs in the list of Anglo-Saxon poets. This Cædmon, whose story contains a large measure of the mythical and the marvellous, is said to have been an unlettered cowherd, unable to contribute his song when in the winter evening the harp was passed from hand to hand around the hearth. "As once he lay slumbering in a stall," says the author of the *Amenities of Literature*, "the apparition of a strange man thus familiarly greeted him : 'Cædmon, sing some song to me.' The cowherd modestly urged that he was mute and unmusical. 'Nevertheless, thou shalt sing !' retorted the benignant apparition. 'What shall I sing ?' rejoined the minstrel who had never sung. 'Sing the origin of things !' The peasant, amazed, found his tongue loosened, and listened to his own voice —a voice which was to reach posterity. The monks of Whitby and 'Holy Hilda' gladly received a brother endowed with the gift of song. They read to him parts of the Scripture ; and 'the good man listened,' said the Venerable Bede, 'like a clean animal ruminating.' He afterwards reproduced in a poetic form what had been recited to him in prose ; and thus we have of him a metrical paraphrase of part of the Bible, besides a short ode in praise of the Creator." Cædmon has been called the "Father of English Song," but in the literal sense this appellation cannot be correctly applied to him, as no English language yet existed ; moreover, Anglo-Saxon scholars have doubted whether the whole of the poem ascribed to him belongs to one period. He is supposed to have died near the end of the seventh century. Of the ode that is said to have come to him in a dream, when his tongue was loosened, the following lines will give an idea. The three peculiar Anglo-Saxon compound letters are modernised into *w*, *dh*, and *th*—

Cædmon and his poem.

"Nu we sciolan herian
Heofon-rices weard,
Metodes mihte,
And his mod-ge-thonc,

Wera wuldor fæder!
Swa he wundra ge-hwæs,
Ece dryhten,
Oord onstealde."

[Now we shall praise
The heaven-kingdom's guardian,
The Creator's might,
And his thought,
Of men the glorious father!
How he, of wonders all
The everlasting father,
The beginning formed.]

In the first line we recognize at once the resemblance to the modern German *nun wir sollen; ge-thonc* and *ge-danke; heofon-riecs, des Himmelreiches*, etc. The lines were irregular, but two words in one line of each couplet had to begin with the same letter; and thus what POPE illustrated by the line "*A*pt *a*lliteration's *a*rtful *a*id" was already understood in the seventh century.

King Alfred and his works.

ALFRED, KING OF THE WEST SAXONS, the darling of the English people, added no little scholarly fame to his glory as a warrior and a legislator. He translated various works into the Anglo-Saxon; among others *The Consolations of Philosophy*, by BOETHIUS, and the historical works of a writer of the preceding period, BEDE, generally called "The Venerable Bede," a monk of Wearmouth, famous for his *Anglo-Saxon History* and other works.

Ælfric's Bible and grammar.

ALFRIC, or ÆLFRIC, archbishop of Canterbury, a learned prelate, made a translation of part of the Bible into English; he also wrote a Latin grammar and some religious treatises. A remarkable monument of Anglo-Saxon literature is found in the metrical narrative of *The Exploits of Beowulf*, a chieftain of the western Danes, a mythical personage, like the heroes of the Iliad. The adventures of Beowulf must not be taken as history; but the poem gives us a vivid picture of the rude Scandinavian heroes carousing in their halls, quaffing huge horns of mead, and sleeping with their armour ready beside them; unrelenting in hatred, pursuing their foes like fate, with implacable vengeance, but rough and hearty in friendship; marauders every one of them, but with a sense of honour and a detestation of cowardice and effeminacy. Thus a distinguished writer says of the hero Beowulf: "We first view him with his followers landing on the shores of a Danish kingling. A single ship in those predatory days could alarm a whole realm. The petty independent provinces of Greece afford a parallel; for Thucydides has marked this period in society, when plunder well fought for was honoured as an heroic enterprise. When a vessel touched on a strange shore, the adventurers were questioned 'whether they were thieves?' a designation which the inquirers did not intend as a term of reproach, nor was it scorned by the valiant; for the spoliation of foreigners, at a time when the law of nations had no existence, seemed no disgrace, while it carried with it something of glory; when the chieftain's sword maintained the swarm of his followers, or acquired for himself an extended dominion." The manuscript of *The Exploits of Beowulf* belongs to the tenth century, but the poem is much older; the personages are Danes, and the circumstances Danish.

Beowulf.

The Saxon Chronicle.

The Saxon Chronicle is another important work running through a lengthened period. It is a history of the events of English history, from the middle of the ninth century to the death of Stephen in 1154, compiled by a number of writers.

The nature of the works of the long period extending to the Norman Conquest may be seen in the following extracts from Ælfric's translation of the Bible into Saxon (St. Matthew xii. v. 1 *et seq.*). The language has a close affinity with the modern German:—

SO HÆLAND FOR ON RESTE-DÆG OFER ÆCERAS; SODLICE HIS HYNGREDE, AND HIG ONGUNNON PLUCCIAN THA EAR, AND ETAN.

So Saviour fared on rest-day over fields; then his learning servants hungered, and they began to pluck the ears and to eat.

SODHLICE THA' THA SUNDOR-HALGAN THÆT GESAWON, HI CWÆDON TO HIM: NU THINE LEORNING-CNIHTAS DOTH THÆT HIM ALYFED NIS RESTE-DAGUN TO DONNE.

When that the Pharisees that saw, they said to him: now this (disciples) do what to them allowed not is on rest-day to do.

AND HE CWÆD TO HIM: NE RÆDDE GE WHÆT DAUID DYDE THA HINE HYNGREDE, AND THA THA MID HIM WÆRON;

And he said to them: Not read ye what David did when him hungered, and they that with him were;

HU HE IN-CODE ON GODES HUS, AND ÆT THA OFFRING-HLAFAS THE NÆRON HIM ALYFEDE TO ETANNE, BUTON THAM SACERDUM ANUM.

How he entered into God's house, and ate the offering-loaves, that not were him allowed to eat, but to the priests alone.

The affinity with modern German is seen at once in the first verse: "Der Heiland fuhr am Raste Tag über die Aecker, und seine Jünger (Lern-Kneehte) hungerten, und sie begannen zu pflücken die Aehren und zu essen."

And in the *Saxon Chroniele* we find it stated for A.D. 596—

HER GREGORIUS PAPA SENDE TO BRYTENE AUGUSTINUM MID WEL MONEGRUM MUNUCUM, THA GODES WORD SCEOLDAN BODIAN ANGEL-CYNNE.

Now Gregory Pope sent to Britain Augustine with full many monks, that God's word should announce to English race.

And for the year 901 the following fact is noted:—

HER FORTH-FERDE ÆLFRED ÆDHELWULFING, SIX NIHTUM ÆR EALRA HALGRA MÆSSAN; SÆ WÆS CYNING OFER

Now forth fared Alfred the Ethelwulfing (son of E.) six nights ere All Saints Mass; he was King over

EAL ANGEL-CYN, BUTAN THAM DÆLE THE
all Angle race, but that part, that
UNDER DENA ON-WEALDE WÆS. AND HE
under Danish rulers was. And he
HEOLD THÆT RICE ODHER-HEALF GEAR LŒS
held that kingdom other-half ($1\frac{1}{2}$) year less
THE THRYTTIG WINTRA.
than thirty winters.

Of the great king Canute it is told that he wrote a song, of which a verse is given in the *Historia Eliensis*, or *Chronicle of Ely*. It refers to a water excursion of the king, who heard the song of the monks of Ely cathedral as his 'cnihtes' (servants, later *knights*) rowed him in his boat on the river.

Canute and the monks of Ely.

MERIE SUNGEN THE MUNECHES BINNEN ELY
Merrily sang the monks within Ely

COVENANTERS' PRISON ON THE BASS ROCK (*see* P. 542).

THA CNUT CHING REU THERE BY;
When Canute King rowed there by;
ROWETH, CNIHTES, NER THE LAND.
Row, servants, near the land,
AND HERE WE THESE MUNECHES SŒNG.
And hear we these monks' song.

The Norman Conquest and its Effects.

Early in the eleventh century the influence of the Normans in England commenced. Edward the Confessor, educated in Normandy and swayed during all his life by Norman predilections, surrounded himself, in his English court, with Norman favourites, to the disgust and anger of the Saxon party. The king's companions affected a contempt for the manners and even the language of the Saxons; Norman soldiers appeared among the followers of English nobles; bills and accounts were frequently written in the tongue of the strangers; and to imitate the language and demeanour of the French became a fashion at the court of the last of the Saxon kings.

The Normans in England.

The French language itself had been formed from a mixture of the Latin with the dialects spoken by the barbarians — Burgundians, Franks, and Visigoths—who set up their rough kingdoms on the ruins of the great Roman empire. Two separate languages were formed in France from the mixture of the Latin with native dialects. The one, spoken in the south, in Provence, the old "Provincia" of the Romans, was known as the *Langue d'oc*, or Provençal; the other, spoken in the regions north of the Loire, was called the *Langue d'oil*. The Provençal was redolent of the Latin beauties, softness, harmony, and flexibility; the Langue d'oil, containing far more of the Germanic or Frankish element, had greater vigour and energy, and eventually spread throughout all France. From this language the modern French has been derived; and the Conquest brought the Norman-French into England.

Langue d'oc and Langue d'oil.

"Fertile in novelties as was this amazing revolution," says the learned author of the *Amenities of Literature*, "the most peculiar was the change of the language. The style of power and authority was Norman; it interpreted the laws, and it was even to torment the rising generation of England: children learned the strange idiom by construing their Latin into French; and thus, by learning two foreign languages together, wholly unlearned their own. Not only were they taught to speak French, but the French character was

adopted in place of their own alphabet. It is a flagrant instance of the Conqueror's design to annihilate the national language, that, finding a college at Oxford with an establishment founded by Alfred to maintain divines who were "to instruct the people in their own vulgar tongue," William decreed that "the annual expense should never after be allowed out of the King's exchequer."

French spoken in England.

Thus, for more than two centuries after the Norman Conquest, two entirely different languages were spoken in England, each exhibiting various differences of dialect. The Norman-French was the language of the conquerors. At a time when to be taken for an Englishman was considered as an unpardonable insult by every proud Norman, it may be supposed that the language of the conquered people met with scant courtesy at the hands of the victors. They banished it from the court, the camp, and the bar, where the Norman-French was the sole language used, while Latin was the language of the Church. How completely ignorant our Norman kings and their immediate successors were of the Saxon tongue is illustrated by the fact that when Henry II., being in Pembrokeshire, was addressed in English as "goode olde Kynge," he turned to his esquire and inquired in French what was meant; and some time later, when the chancellor of Richard I., flying from England, had disguised himself as a female hawker, carrying an ell wand and a bundle of cloth, his assumed character was at once detected when some fishermen's wives asked him the price of his cloth; for he had not enough English to reply to a simple question.

Degradation of the Saxons.

But still the Saxon was the language of the great majority in England. The burghers, the peasants—in fact, the bulk of the people—were of Saxon origin, and adhered to the language of their forefathers; and in the end, instead of superseding the Saxon, the Norman-French became absorbed in it, serving to increase its richness and variety. The Anglo-Saxon continued to be the foundation of the language. Certain changes and modifications were introduced in the course of time, and with the addition of many Norman words; but upon the old Saxon lines was built up the modern English language.

The Saxon, the people's language.

The Normans were patrons of literature, so far as it was understood in those days; and their great men loved to hear themselves praised by the menestrels or trouvères, or, as they were called in the Provençal, troubadours or trobadores. Thus, in the two centuries succeeding the Conquest, the names of Norman poets occur frequently. They generally sang the deeds of some great hero, such as Roland the Paladin, the famous nephew of Charlemagne, or the story of some great achievement; and the minstrels who sang these romances to the harp in the baron's hall became important as the distributors, and sometimes as the composers, of the poetry of those days of chivalry and romance.

THE MONUMENT (*see* p. 570).

XLIV.

CHARLES II. (*continued*).

The Triple Alliance.

IT seemed as though counsels more worthy of England were about to prevail in the government when a triple alliance was concluded between England, Holland, and Sweden. This great

act of statesmanship, which was achieved through the exertions of Sir William Temple, the English ambassador at the Hague, and John de Witt, grand pensionary of the Dutch Republic, had for its object the union of the Protestant powers against the dangerous and encroaching ambition of Louis XIV., who threatened to become the autocrat of Europe. This union for mutual defence was entirely unpalatable to the French king, whose schemes it would have rendered abortive. Accordingly Louis practised on the necessities of his brother king, who was always in want of money and was not likely to hesitate between his conscience and a bribe. Clarendon was no longer at the head of affairs; he had been used by his master as a scapegoat, and driven forth to end his days in exile. The "Cabal" ministry, remarkable for the talents and infamous for the vices of its chief members, Clifford, Ashley, Buckingham, Arlington, and Lauderdale, now managed the affairs of the country; and when Temple returned to England, after concluding the treaty, he found that some sinister influence was strong against him. He was coldly received, and soon perceived that the alliance he had concluded would not be allowed to stand.

The Cabal ministry.

Louis XIV. had been at work. With all the skill of a wily and finished plotter, he had sent over to England Charles's sister, the charming Duchess Henrietta of Orleans; and in the train of the duchess came that Louise de la Querouaille, who afterwards, as "Madam Carwell," Duchess of Portsmouth, became notorious and hated in England, as the most rapacious and unscrupulous of Charles's mistresses. These remarkable envoys induced Charles to become a party to the infamous treaty of Dover, signed on May 22nd, 1670, by which, in consideration of a pension of £200,000 yearly, so long as the war lasted that Louis proposed commencing against Spain and Holland, the English king bound himself to support the cause of Louis against the country with which he had so recently concluded an alliance, and to abjure his religion in favour of the Romish Church. To the caution of Louis it was owing, that this last stipulation was kept secret from the English people. From that time until the revolution of 1688, which drove James II. from the throne, England occupied the ignoble position of a pensioner of France; binding herself to make war or conclude peace at the pleasure of a patron, and her king receiving from that patron's hand the wages of subserviency.

Treaty of Dover, 1670.

Among the devices of Charles for obtaining money, none caused so much anger as the shutting up of the exchequer, in 1672. The leading goldsmiths, who were at that time the bankers of London, had advanced sums amounting to more than a million and a quarter sterling, according to the custom of that day, in anticipation of taxes that were to be collected. Suddenly the king laid hands on the money in the exchequer, announcing that interest at the rate of 6 per cent. would be allowed to the lenders, but that the principal would not be repaid that year. Thus a number of unfortunate traders, suddenly deprived of their capital, were ruined.

Shutting up of the Exchequer, 1672.

The war declared by England against Holland, at the desire of Louis XIV., is chiefly remarkable for the battle of Southwold Bay, on the 28th of May, 1672, when the Duke of York encountered the veteran De Ruyter. The contest was gallant, but indecisive. At last the war became so unpopular in England that, after the breaking up of the Cabal ministry, the king was compelled to make peace with Holland, which country was thus left to deal on more equal terms with its great enemy, Louis of France. But Charles soon after entered into an engagement with the French king, in which it was arranged that neither should make treaties in future without the consent of the other. This agreement was ratified by a pension of £100,000 paid by Louis.

War with Holland; battle of Southwold Bay, 1672.

Such a stipulation as that of the treaty of Dover regarding the king's change of religion could not remain entirely a secret; the Duke of York and his duchess, Anne Hyde, had openly avowed themselves Romanists some time before; and an increasing uneasiness took possession of the public mind with respect to the Catholics. A Declaration of Indulgence granted by the king on his own authority in 1672, which gave to nonconformists of all denominations the privilege of worshipping according to their creeds in their own houses, greatly disturbed the public mind, being considered as intended to favour the Romanists. The parliament of 1673 accordingly insisted that the king should withdraw the measure; and the Test Act was passed, which stipulated that the holder of every office under the crown should subscribe to certain oaths, and should in addition take the sacrament at least once in every six months according to the form used by the Church of England, as a proof or test of his being a member of that Church. One effect of this measure was that the Duke of York was compelled to give up his office of Lord High Admiral. The duke, indeed, became one of the most unpopular men in England. The king had no legitimate children, and James was the heir presumptive to the throne. His open avowal of conversion to Romanism, and his marriage with Mary of Modena, after the death of his first wife, Anne Hyde, gave rise to a grave suspicion that the Protestant religion would not be safe in England if he came to the throne. The feeling against the Roman Catholics was very strong. Dryden painted them in the worst colours, as the Jebusites, in his "Absalom and Achitophel"; the inscription on the monument erected on Fish Street Hill to commemorate the great fire accused them of setting fire to London; and a large portion of the community desired to see the succession settled upon the king's natural son, the Duke of

Declaration of Indulgence, 1672.

Test Act, 1673.

Irritation against the Catholics.

Monmouth, who, whimsically enough, was looked upon as the champion of Protestantism.

After the breaking up of the Cabal ministry, on whose fall Sir Thomas Osborne was made Lord Treasurer with the title of Earl of Danby, and took the chief direction of public affairs, the feeling against the Roman Catholics grew stronger. Then it was that a scoundrel named Titus Oates determined to turn the popular delusion to his own account. He pretended that during a residence in Jesuit colleges at Valladolid and St. Omer—for Oates professed to have become a convert to Romanism—he had received intelligence of a plot to murder Charles II. and place the Duke of York on the throne if he would undertake to restore popery in England; if not, he also was to be put to death. A massacre of Protestants was, according to Oates, part of the scheme, which was to have been carried out by conspirators from France, England, and Spain.

Titus Oates and the Papist plot.

That the man was a gross impostor must have been abundantly clear to any unprejudiced mind; but the public were in a condition to believe anything, and the infamous Oates was hailed as a patriot who had saved his country from a great danger. The secretary to the late Duchess of York, one Coleman, was denounced as having actively participated in the plot. He was arrested, and his papers were seized. There were among them many compromising documents, which the popular excitement magnified into proofs of guilt. In particular it was asserted that a large bribe had been offered to the king's physician, Sir George Wakeman, for poisoning his master. Danby, the minister, affected to believe in the reality of the popish conspiracy. The houses of parliament then issued a resolution stating: "The Lords and Commons are of opinion that there hath been, and still is, a damnable and hellish plot, contrived and carried on by the popish recusants, for assassinating the king, for subverting the government, and for rooting out and destroying the Protestant religion."

Coleman's plot, etc.

Various Catholic nobles, Lord Stafford, Lord Petre, and others, were arrested. The popular fury had been increased by the fact that Sir Edmondsbury Godfrey, the magistrate before whom Oates had given his evidence, was found murdered near Primrose Hill; and it was declared that this had been done by Romanists out of malice and revenge. The success of the perjury of Oates, who contradicted himself in the wildest manner, and was rewarded with a large pension, and lodged in Whitehall, called forth a second false witness, Bedloe, who strove to outdo Oates in the extravagance of his denunciations, and even accused the queen of being privy to the plot against her husband's life. On this occasion, however, Charles, though he had wofully neglected his consort, stood forward to protect her. "They think I have a mind to a new wife," he said, "but for all that I will not see an innocent woman abused." Coleman was tried, found guilty, and executed; and a number of people were brought to the scaffold, and many more imprisoned, for alleged complicity in this plot, which later times have denounced as a monstrous fiction invented by Oates and Bedloe.

Arrest of Catholic nobles.

Executions.

Soon afterwards the treasurer, Lord Danby, fell; Montague, the French ambassador, having produced against him a letter written while the negotiations for the treaty of Nimeguen were going on, and offering to sell the king's neutrality to Louis in return for a large sum of money to be paid annually for three years. Danby was impeached by the commons of high treason; but the lords were inclined to take a lenient view of what he had done, and the king prevented matters from proceeding to extremity by dissolving the parliament, in January 1679. The new parliament, called in the next year, resumed the proceedings against Danby, who was committed to the Tower.

Fall of Danby, the Lord Treasurer.

An attempt was now made to carry on the affairs of the kingdom by a council of thirty, with Sir William Temple, the popular and moderate negotiator of the Triple Alliance, at their head; Shaftesbury (the Achitophel of Dryden), Halifax, and Sunderland were the other principal members.

This third parliament of Charles II. is remarkable for having passed the celebrated Habeas Corpus Act, a valuable upholder of English liberty. This measure secures every subject from the tyrannical infliction of a lengthened imprisonment before trial. It provides that every accused person (except for felony or treason) shall have the right of suing out a writ commanding the person who has him in custody to produce him bodily in court, that the indictment against him may be examined, and that he may be brought to trial at the next assizes or sessions after his committal; and a heavy penalty is incurred by a magistrate refusing the writ of Habeas Corpus when called upon to grant it. From this time the king and the parliament were more and more at variance, chiefly from the efforts of the commons to pass a bill for the exclusion of the Duke of York from the succession. The popular party, who afterwards became known as the Whigs, had Shaftesbury for a leader; while the court party, who upheld the doctrines of passive obedience, non-resistance, and the prerogative of the king, became known as Tories. The third parliament, in contrast to its predecessor, which had sat for nearly eighteen years, was quickly dismissed. A fourth was prorogued for a year almost immediately after being summoned, and was dissolved upon the commons passing a bill, which was thrown out in the lords, for the exclusion of the Duke of York. The fifth and last parliament was dismissed on the 28th of March, 1681, after having sat only a few days. Its offence was a determination, like that of its predecessor, to exclude the Duke of York from the throne. The king might be said now to have completely triumphed over the strong opposition once brought against him.

The third parliament.

The Exclusion Bill.

Fourth and fifth parliaments.

ZOOLOGY.

XVIII.

The Bear Family.

The bears, the third great group of land carnivora, are not so marked by special characters as the rest of the tribe. As a rule they walk upon the entire sole of the foot, and are consequently called plantigrade; they have five toes on all their paws, every one having good claws. They are adapted to a more varied diet than the cats, and while their canine teeth are of considerable though not excessive size, their grinders, more numerous than those of the cats, have crowns, with broad uneven surfaces, contrasting with the sharp scissor-like teeth which are the special possession of the dogs and cats. To correspond with this, the lower jaw can be moved sideways as well as vertically, and roots, fruit, ants, etc., can be ground small. Some bears, however, are constantly flesh-eaters, while all will eat animal food if reduced to extremities. The shaggy coat and narrow pointed snout of the bears is well known, and few animals are more handsome than the Polar bear, with his nearly white hair, and his never-tiring spirit. Many members of the family, however, are both fierce and ugly; and inasmuch as they are found in most large forest districts, except in Africa south of the Sahara, and in Australasia, the interest connected with these great creatures is wide-spread.

Family characters.

POLAR BEAR.

Food.

SLOTH BEAR.

The Polar bear, with his long head and short tail, is well known to Arctic travellers, and a constant attendant on seal-hunters. He is very persevering in his pursuit of seals, over whom he has the advantage in their necessity to breathe air and their less rapid motion on land. He is the largest bear, reaching nine feet in length, and possibly he is the heaviest weight in the carnivorous order, with the exception of the walrus and some of the eared seals. He is nearest to the wolves in one habit: he kills by biting rather than by hugging like other bears when they come to close quarters with quadrupeds or bipeds. The Esquimaux hunt this great game with dogs, and eat parts of his flesh, and use the oil extracted from him for burning. The bear when tracked rushes off at full speed, followed by the hunter and his dogs; but after some time he is wont to stand at bay, becoming very fierce. He is no such match for a couple of hunters, or even one, as the lions and tigers. It appears that only the females who are with young hibernate, getting covered by snow early in winter while fat and in good condition, and finally bringing forth the young ones in the cavity melted around by their bodily heat. The mother becomes thin during the long rest and enclosure.

Polar bear.

Hunted by Esquimaux.

The grizzly bear of the Rocky Mountains of America attains nearly the size and power of the Polar bear; he is the fiercest of the bears, and of great strength, being capable of dragging a huge buffalo after him. In figure he is well marked by the almost invisible tail and long white claws.

Grizzly bears.

The American black bear largely feeds upon fruits, insects, eggs, etc., and does not habitually kill or eat animals. The Syrian bear also feeds usually on vegetable diet, and only kills when compelled by hunger. It is this bear of whose destruction by David we have an ancient record. The Himalayan bear, ranging as far as China and part of Siberia, and the Malayan bear, extending from the continent into the great Malay islands, are principally fruit and grain-eaters. In captivity they are marked by their walking on the hind-legs and by their playful gambolling.

The brown bear of northern and central Europe, Spain, Siberia, Japan, and Arctic North America has the widest geographical range. He does not possess grace or elegance, and, like many of the most powerful animals, is not gregarious. His food is very considerably vegetarian, including both fruits and roots. His taste for honey also is very marked, and is often the means of bringing upon him stinging on-

Brown bears.

slaughts from the bees that he disturbs, his snout being naturally the part selected and available for attack. He will also eat ants and the smaller quadrupeds. The proverbial bear's hug, natural to most bears, is pre-eminently disagreeable to feel, and soon gets rid of human antagonists, unless they can kill the enemy with a weapon, or are otherwise relieved.

"The hug."

There is no doubt that honey helps to fatten bears in summer and autumn for the winter rest they take. When they commence their hibernation they are very fat, taking care to get abundant meals for some time before they hide or cover themselves in a cave or hole, and lie down. In this state the action of their organs is reduced to an extremely low ebb. Their functions do not absolutely cease, but they go on slowly or slightly, so that the store of fat is only gradually used up. When the bear emerges from his retirement in spring he is much wasted, and it is some little time before by hearty feeding he is again in good condition.

Hibernation.

Brown bears are often docile when in confinement, and have been taught many tricks, and the accomplishment of dancing on their hind-legs. They are capable of showing much affection to their own kind: this is especially the case with the mothers in regard to their cubs. "As surly as a bear" expresses an idea deeply rooted in the human mind; and it is true when the bear is provoked.

Higher faculties.

The sloth bear of Hindostan and Ceylon is nearly black, with a whitish snout and some other white patches, and is between five and six feet in average length. In ugliness he rivals many of his compeers. His prominent snout and large lips are most at home when he has rooted up an ant-hill or bee-colony and is sucking vigorously, drawing all the creatures and food within into his throat, while an alternate blast of air from his lungs disperses the uneatable crumblings of the nest. The Indian natives are in considerable dread of this large bear, and unwilling to encounter him unless protected by a charm.

The sloth bear.

XLV.

SYNTAX OF THE VERB (*continued*).

The Subjunctive Mood.

THE *Subjunctive* mood is a *subjoined* or dependent mood, depending on something going before, to govern it. This may be governed by various words and phrases, as seen by the following conjunctions:

(1) *Conjunctions governing the subjunctive—*

ut, { *that, in order that, so that, although* (sentences construed by the *infinitive*). / *that* and carry "*not*" (after verbs of *fear*).

quo, { *that* (and carry "*the*" to the comparative).

ne, { *not* (with *imperative* or *subj.* used imperatively). / *that*, and carry "*not*"; *lest.* / *that* (after verbs of *fear*). / *ne* is sometimes an important question of appeal. *Ne doleam?*—am I to grieve?

neve, neu, { *and that not, nor.*

quin, { *but* (as used after *negatives*). / the *relative* with *not.* / "*as not*" with *infin.* / *from* or *without*, with the *participial substantive.*

quominus, { (*by which—the less*), *that not.* / *from*, with the participial substantive.

utinam, *would that.*

dum, modo, dummodo, { *provided that, if only* (after these conjunctions "*not*" is *ne*).

quasi, ut si, ac si, tanquam, { *as if.* / (*pres. subj.* construed by the *perfect* after these conjunctions.)

licet, *although.*

quamvis, *however much; although.*

quum, *since; although.*

nedum, nedum ut, { *much less.*

quò, *that.*

(2) *Other conjunctions*, several of which take the subjunctive occasionally (especially with the *imperfect* and *pluperfect*)—

quod, { *because, that* (after verbs expressing *emotions*, and when it refers to a *demonstrative* pronoun).

quàm, { takes the indicative in the sense of *when*, but the subjunctive in the sense of *although* or *since.*

postquam, posteaquam, { *after* (generally with *perf.* indicative).

simulac, simulatque, ut primum, quum primum, { *as soon as* (generally with *perf.* indicative).

ut, ubi, { *when, after.*

antequam, priusquam, { *before.*

dum, donec, quoad, { *until, as long as* (dum, *whilst*).

quam diu, *as long as.*

si, *if.*

sin, *but if*, sin minus, *but if not.*

nisi, ni, *unless.*

etsi, tametsi, etiamsi, { *although, even though.*

et, que, ac, atque, *and* (*ac* seldom before *k* sounds).

etiam (*before its* word), quoque (*after its* word), et, { *even, also, too*; (*etiam*, in answers, is "*yes*").

aut, vel, ve, *or.*

verum, vero, *but.*

autem, at, ast, atqui, sed, *but.*
tamen, attamen, } *yet, notwithstanding, never-*
veruntamen, } *theless.*
quia, *because.*
quippe, *because, inasmuch as.*
quoniam, } *since.*
quandoquidem, }
quando, *when, since.*
siquidem, *since, if indeed.*
quatenus, *in as far as.*
nam, namque, } *for.*
enim, etenim, }
itaque, *and so, therefore.*
igitur, }
propterea, }
idcirco, } *therefore.*
ergo, }
ideo, }
hinc, *hence, therefore.*
quare, }
quapropter, } *wherefore.*
quamobrem, }
quocirca, }
et—et, }
atque—atque, }
ac—ac, } *both—and;*
tam—quam, } *not only—but also.*
tum—tum, }
quum—tum, }
non solum, } verum (*or*) *not only.*
non modo, } sed) etiam } *but also.*
aut—aut, } *either, or.*
vel—vel, }
sive—sive, } *be it that—or be it that; either—*
seu—seu, } *or, whether—or.*
nunc—nunc, } *now—now; one while—another.*
modo—modo, }
nec—nec, } *neither—nor.*
neque—neque, }
nec, alone, may often be construed by "*and*" and "*not*" carried to the verb.

Observe (1) that *antequam* and *priusquam* mostly take the subjunctive mood in the imperfect and pluperfect tenses, and whenever the sense implies that one thing is *necessary* or designed to precede another. The indicative mood is only used when mere priority of time is to be expressed. (2) *Ante quam* and *prius quam* are sometimes separated, the *ante* and *prius* being placed in one part of the sentence (earlier), and the *quàm* in the latter part of the sentence—as in *Prius in urbem venit, quàm id audiverim*, he came into the city before I heard of it.

Dum, donec, quoad, in the sense of *until*, takes the subjunctive mood when there is reference to an object to be obtained. In the sense of *as long as*, according to Madrig, they govern the indicative mood.

Si and its compounds take the subjunctive of the imperfect and pluperfect, and of the other tenses, when the condition is to be expressed *doubtfully*. In most conditional clauses, condition may take place.

I. With both clauses in the indicative mood, when the condition is stated without any expression of doubt—as *Si bonus es, justus es*, if thou art good, thou art just.

II. With the conditional clause in the subjunctive and the other clause in the indicative mood, when the condition, though doubtful, seems very likely to be realised—as *Si veniam id dabo*, if I come I will give that thing.

III. With both clauses in the subjunctive when the condition is doubtful, and does not seem likely to be realised, or is now not sure to be realised—as *Si venerit, id daret*, if he should come, he would give that thing; *si venisset, id dedisset*, if he had come, he would have given that thing.

Quò, the conjunction, governs the subjunctive in the sense of *in order that*, to denote *a purpose*—as in *corrupisse dicitur Cluentius judicium pecuniâ quò inimicum suum innocentem condemnaret*, Cluentius is said to have bribed the court for the purpose of condemning his private enemy though innocent; but more generally than not, *quò* is used with the comparative adjective or adverb, and thus is equal to *ut eo*—as in *Vitam honestam age, quo magis feliciter moriaris*, live an honourable life, that ye may die the more happily. Here *quò magis feliciter* is equivalent to *ut eò magis feliciter.*

Exercises.

Translate into English :—

Civitati persuasit, ut de finibus suis exirent. Te magnopere hortor ut hos libros de philosophia diligenter legas. Legem brevem esse oportet, quò facilius in memoriâ teneatur. Tarquinius adeo servum diligebat, ut is ejus vulgo haberetur filius. Romani civis ab aratro abduxerunt Cincinnatum, ut dictator esset. Fac ut hæc omnia sciam. Veni huc, ut hanc pulcherrimam urbem meis ipsius oculis viderem. Medico puto aliquid dandum esse quò sit studiosior. Condiunt Egyptio mortuos suos, ut quàm maximè permaneant diuturna corpora. Platonem ferunt, ut Pythagoreos cognosceret, in Italiam venisse. Cæsar cum Pompeio Crassoque iniit societatem, ne quid ageretur in republicâ administranda, quod displicuisset ulli e tribus. Ut jugulent homines surgunt de nocte latrones. Hoc agam, ne tibi longus videar. Ne idoneo pateant benè audere velle ut ille malè audiat. (Observe that *benè audere* and *malè audere* are often, as here, used of being well or ill spoken of.) Catilina Massiliam in exilium proficisci, se dixit, non quo sibi tanti sceleris conscius, sed uti respublica quieta foret, nove ex suâ contentione seditio oraretur.

Translate into Latin :—

The ambassadors come to me that they may gain peace. He says these things to the consuls that he may appear braver than he is. This is done that the result may be more clearly seen by all men who observe it. Romulus, in order to increase the number of his citizens, opened an asylum (*asylum*). I exhort you, my good friends, that you should always study the best books. I advise you to do this (that you may do this). The power of virtue is so great that we love it and admire even in an enemy. He praises that man that he may be praised by him. That ye may live with honour, do things that are honourable. He will blame that man, that he may avenge himself. He was pretending to be mad that he might escape the toils of warfare, a thing which no

man that is brave and honourable could possibly think of doing. He spoke much (*say* many things) that he might appear to understand the things about which he was speaking to his friends.

Self-Examination Questions.

Learn off the conjunctions that govern the subjunctive mood, and write them out. Which of these, and under what conditions, govern the indicative mood as well? Write out the rule of conditional sentences as here given. What is often the force of *quò* with the subjunctive, when used with a comparative degree?

II.

SOUND (*continued*).

IN considering the velocity of sound in air we must bear in mind the fact that as long as the temperature remains the same we cannot alter the density of the air without at the same time altering to precisely the same amount its elasticity. This fact is embodied in a law known as that of Boyle and Marriotte, because simultaneously discovered by them about the end of the last century. The law is this: "The temperature remaining the same, the volume (or density) of a gas is inversely as the pressure it supports."* In other words, if you have, say, a cubic foot of air at a pressure of 15 lb., and you submit this to a pressure of 30 lb., it will be compressed to the volume of half a cubic foot. On the other hand, if the pressure be reduced to $7\frac{1}{2}$ lb. the gas will expand till it occupies a space of two cubic feet. Now, the pressure which a gas can support is obviously the measure of its elasticity, and its volume is a measure of its density, consequently what Boyle's law really implies is that while the temperature remains unchanged, the density and the elasticity of a gas may respectively be changed, but the *relation* between them must always remain constant. Obviously, then, so long as the temperature of the air remains the same, no alteration in the velocity of sound can take place, however the density and elasticity of the air may vary.

Boyle's law.

Bearing in mind the fact that it is the relation between the elasticity and density of any medium which has to be considered in calculating the velocity of sound through it, there will be no difficulty in understanding how it is that sound has so much greater a velocity in such media as water and various solids than it has in air. The explanation, of course, is, that in these media the proportion between the elasticity and the density is so much greater than in air. Subjoined is a list of substances, with the velocity of sound through each.

Velocity of sound in various media.

* This law is not absolutely true of all gases.

Gases at a temperature of 0° C.

Air	1090 feet.
Oxygen	1040 „
Hydrogen	4164 „
Carbonic acid	858 „
Carbonic oxide	1107 „
Nitrous oxide	859 „
Olefiant gas	1030 „

Velocity of sound through liquids.

	Temperature.	Velocity.
River water	15° C.	4714 feet.
Sea water	20	4768 „
Solution of common salt	18	5132 „
„ sulphate soda	20	5194 „
Common alcohol	20	4218 „
Absolute alcohol	23	3804 „
Sulphuric ether	0	3801 „

Velocity of sound through metals.

	At 20° C.	At 100° C.	At 200° C.
Lead	4030	3951	——
Gold	5717	5640	5619
Silver	8553	8658	8127
Copper	11666	10802	9690
Platinum	8815	8437	8079
Iron	16822	17386	15483
Cast steel	16357	16153	15709

The following simple experiment, suggested by Professor Tyndall, well illustrates the difference in the velocity of sound in air and in iron. Find one of the longest horizontal iron bars, such as are used in the parks for fencing, and place your ear close to it at one end, while a friend gives the other end a sharp blow: two sounds will be heard, the first transmitted through the iron, the second through the air.

Experimental illustration.

Knowing the elasticity and density of a gas, it is possible to calculate the velocity of sound in it, and in this manner Newton calculated the velocity of sound in air. To his surprise, however, it did not agree with the observed velocity, being only 916 feet per second. For a long time this discrepancy was a great puzzle to physicists, until at last the cause was discovered by Laplace, the celebrated French mathematician. The explanation given by him, and now universally accepted, is that the differences of temperature in the sound-wave itself, caused by the condensation and rarefaction of the air, augments the velocity of sound; and it is found that if the effect of these variations in temperature be taken into account the theoretical and the observed velocities perfectly agree.

FIG. 4.

When air is compressed heat is evolved; when air is allowed to expand cold is produced. Consequently, in the condensation of a sound-wave the temperature of the air is above, while in the rarefaction it is below, the temperature of the surrounding air. Inasmuch, however, as the loss of heat of the rarefaction exactly

Changes of temperature in the sound-waves.

balances the gain of heat in the condensation, the *average* temperature of the sound-wave is the same as that in the surrounding air, and consequently does not affect the temperature of the latter. Moreover, the effect upon the velocity of sound from the mere changes of density in the sound-wave would, *if we disregard the accompanying change of temperature*, be *nil*. A little consideration will, however, readily make apparent the real influences at work in accelerating the velocity. To make ourselves perfectly clear we must again refer to our imaginary chain of air particles. Now, when these air particles are at rest they remain at such a distance from each other as is determined by their elasticity, which may be figured as a spring or buffer between them. Let the middle line in fig. 5 represent such a row of particles at rest.

Now suppose some sonorous body, say the prong of a vibrating tuning-fork, to strike *a*, *a* is driven towards *b*, *b* towards *c*, and so on as before explained, and a wave of condensation runs along to *o'*, so that by the time *a* has reached *a'*, the whole of the particles from *a'* to *o'* form the condensed portion of a wave of sound. Now, in condensing these particles heat has been produced, and that heat has increased the elasticity of the particles *a o*; consequently the rapidity with which *a* passes on the push it has received to *b* is *increased*, and, the same being the case with the other particles, the velocity of sound is increased by the condensation of the air.

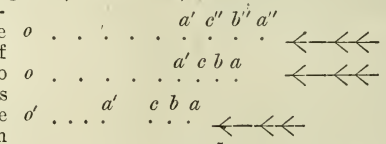


FIG. 5.

N.B.—The arrows show the direction of the sound-wave.

The increase of velocity owing to the rarefaction is not quite so easy, but will nevertheless be understood if care be taken to master the following considerations. When *a* has reached *a'* the tuning-fork begins to perform the second half of its vibrations; it retreats from *a* and the latter follows it; *b* follows *a*, *c* follows *b*, and so on, until the particles from *a* to *o* form the rarefied portion of a sound-wave, and take up the position *a'' o''*. In becoming thus rarefied cold is produced. Now, in considering the motion of *b* after *a* it will be obvious that the rapidity with which *b* will follow *a* will depend upon the difference of the elasticity between *a* and *b* and that between *b* and *c*; if you suddenly reduce the elasticity between *a* and *b* without affecting that between *b* and *c*, the speed with which *b* follows *a* will be *increased*. This is the part played by the cold produced by the rarefaction of *a b*,—it decreases the elasticity between them. What is true of *a* and *b* is true of all the other particles in the series, and thus the *cold* produced by the rarefaction *as well as the heat* produced by the condensation of a sound-wave accelerates the velocity of sound in air.

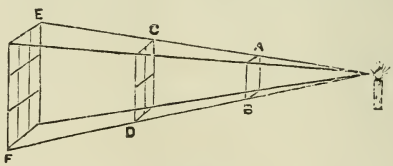


FIG. 6.

The loudness of a sound is termed its "*intensity*," and this depends, (1) upon the density of the air, (2) upon the amplitude of the vibrations, and, (3) upon the distance. The experiment already described of ringing a bell under the receiver of an air-pump amply proves that the denser the air the louder the sound; moreover, it is matter of common observation with travellers that the greater the elevation the less is the intensity of a given sound. Upon the top of a lofty mountain the sound of the human voice is greatly enfeebled, while the firing of a pistol produces a sound no louder than that of a pop-gun at the sea-level. In the case of hydrogen gas, which has only about $\frac{1}{14}$th of the density of air, sound is very greatly enfeebled, but this is not owing merely to the relatively less density of hydrogen as compared with air, but also to the fact that the hydrogen particles are much more mobile and elastic than those of air; consequently, when they are struck by a sonorous body they tend to slip away rather than to pass on the impulse to their neighbours, and thus there is great difficulty in forming sound-waves in hydrogen. If this gas be inhaled, and caused to set the vocal chords, by which the voice is produced, in motion, the sounds are extremely thin and shrill.

Intensity of sound.

The intensity of a sound depends upon the amplitude of the vibrations; it is, in fact, *directly proportional to the square of the amplitude*.

Intensity and amplitude.

The intensity of a sound is found to decrease with the distance according to the following law:—*The intensity of sound is inversely proportional to the square of the distance.* This law in simple language means, Double the distance and you divide the intensity by four; halve the distance and you increase the intensity fourfold. The same law applies to both light and heat, and may be illustrated by the following simple experiment.

Intensity and distance.

Take a candle or small lamp, and a small white cardboard screen, as in fig. 6. Get a piece of paper the exact size of the screen, and fold it into four; get another similar piece, and fold it into nine. Now place the candle exactly three feet from the screen, and place the sheet of paper folded nine times at one foot from the candle, as A B; it will be found that its shadow exactly covers the screen, E F, which is nine times as large, showing that the light which covers a space A B at one foot from the candle covers a space nine times as great at three times the distance, and consequently that its intensity upon any given portion of A B is nine times as great as upon an equal space on E F. In the same way, removing the screen two feet from the candle, and placing the paper

Experimental illustration.

four times folded one foot from the candle, its shadow will exactly cover the screen four times its size.

The intensity of sound further depends upon the maximum velocity of the vibrating particles; it is in fact directly proportional to the square of this maximum velocity.

If a sound be made to pass through air confined in tubes, its intensity no longer follows the law of inverse squares which governs it when transmitted through the open air. The following simple apparatus illustrates this in a very interesting and amusing manner. Make a number of tubes out of cartridge paper, and make also some paper collars, so that the tubes may be fitted into them, and thus make, when necessary, one long tube. Put two or three together and make a cone to fit on to one end of this compound tube, as in fig. 7. In front of the cone place a lighted candle; clapping the hands or two books together at the other end will instantly extinguish the candle. Another amusing experiment is to make as long a tube as possible by uniting several small ones. Now hold a watch at one end, and let some one place their ear at the other end: the ticking of the watch will be plainly heard, although without the tube it is inaudible at so great a distance. Fig. 8 represents a piece of apparatus devised by Professor Tyndall's assistant, Mr. Cotterell, to illustrate similar facts. A tin tube fifteen feet long has both its ends closed with sheet india-rubber. At one end, E, a hammer having a spring handle rests against the india-rubber; at the other end is an arrangement for striking a bell, C. When the hammer is pulled back and allowed to go it strikes the india-rubber, and the impulse is passed through the air in the tube, pushes out the india-rubber at the other end, which in its turn pushes against the cork A on the other end of the lever A B, and thus causes the latter to ring the bell. If hydrogen be substituted for air the bell does not ring. The distance to which sound may be transmitted through tubes has never been accurately ascertained; but M. Biot, of Paris, found that a conversation in a low voice could be maintained through an iron tube 3,120 feet in length. An application of this discovery is found in the ordinary speaking tubes laid on from one part of a large building to another.

Sound in tubes.

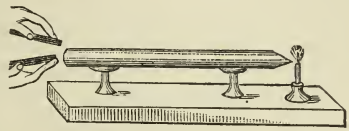


FIG. 7.

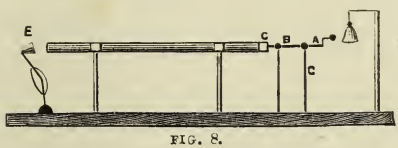


FIG. 8.

Since sound consists in a wave propagation, we naturally expect to find it exhibiting all the ordinary properties of waves. Thus, *e.g.*, we shall find it is *reflected* according to the same law as light. It is *refracted* also in passing from one medium to another of different elasticity or density. This has been proved by concentrating in a focus the ticking of a watch, and rendering it audible at a considerable distance by a lens of collodion films filled with carbonic acid gas.

XLVI.

Study on the Auxiliary Verbs of Mood.

In German a certain number of verbs are used to express the ideas given in English by such words as MUST, which signifies necessity — **Der Tag muß nach dem Morgen kommen,** The day must come (necessarily comes) after the morning; CAN, which signifies ability— **Ich kann Ihnen die Erklärung geben,** I can (am able to) give you the explanation; MAY, which in one sense signifies a permission granted —**Er darf heute nicht ausgehen, weil er seine Arbeit nicht vollendet hat,** He may not (is not permitted to) go out to-day because he has not finished his work; SHALL, which signifies a command or a duty (in which latter case it is rendered in English by the word *ought*) — **Du sollst diesen Brief schreiben ehe du fortgehen mußt,** Thou shalt write this letter before thou art obliged to (must) go away; WILL, a determination or resolution differing from the **werden,** which generally expresses an occurrence, something that happens (**es wird regnen,** it will rain)—**Ich will dieses nicht thun, weil es nicht recht ist,** I will not do this, because it is not right, etc.

These verbs are called auxiliaries of *mood*. They are auxiliaries because they express no complete idea in themselves, but modify the verb to which they are prefixed—he *may* write, he *can* write, he *must* write—signifying respectively permission, ability, necessity, to write.

The auxiliary verbs of mood are seven in number, and are as follows:—

Müssen (Ich muß, ich mußte, gemußt),
muess'-en ich muss ich muss'-te ge'-musst
to be obliged.

dürfen (Ich darf, ich durfte, gedurft),
duerr'-fen ich darrf ich doorrf'-te ge-doorft'
to be allowed, etc.

können (Ich kann, ich konnte, gekonnt),
koen'-en ich kann ich konn'-te ge-konnt'
to be able.

mögen (Ich mag, ich mochte, gemocht),
moeh'-gen ich maag ich moch'-te ge'-mocht
to like, etc.

wollen, (Ich will, ich wollte, gewollt),
vol'-len ich vill ich voll'-te ge-vollt'
to be willing.

sollen (Ich soll, ich sollte, gesollt),
zol'-len ich zoll ich zoll'-te ge-zollt'
to be obliged as a duty, etc.

lassen (Ich lasse, ich ließ, gelassen),
lahss'-en ich lahss'-e ich liess ge-lahss'-en
to let or cause.

In constructing sentences with these verbs, two rules must be kept in mind:

I. The sign of the infinitive mood **zu** is not used where an infinitive follows a verb of mood —**Er mag kommen, wir dürfen gehen**, he likes to come, we are allowed to go; just as in English we do not use the sign *to* after *shall, will, can, may*, etc.

II. When the auxiliary verb of mood is used with another verb in the past, the second verb is put in the infinitive mood instead of in the past participle. For instance—**Ich habe lange gewünſcht dieſes Buch zu leſen** (here there is no verb of mood), I have long been wishing to read this book. On the other hand—**Ich habe dieſes Haus nicht kaufen können** (verb of mood used here), I have not been able to buy this house. (Notice omission of **zu** before the infinitive **kaufen**, and the rendering of the past participle *been* able by the infinitive **können**.

Conjugation of the Auxiliary Verbs of Mood.

Müſſen, to be obliged (compelled by necessity), has the same meaning as the English word MUST: **Was ich dir befehle, das mußt du thun**, What I command thee, that must thou do; **Er muß wenigſtens drei hundert Pfund verloren haben**, He must have lost at least £300; **Jetzt muß ich zu meinem Lehrer**, Now must I (go) to my teacher. Here it is used elliptically, as sometimes in English—"I must to horse."

INDICATIVE.		SUBJUNCTIVE.	
Present Tense.		*Present Tense.*	
Ich muß, *ich mooss*	I must, etc.	Ich müſſe,	(that) I must, etc.
Du mußt,		Du müſſeſt,	
Er muß,		Er müſſe,	
Wir müſſen,		Wir müſſen,	
Ihr müſſet (müßt),		Ihr müſſet,	
Sie müſſen,		Sie müſſen,	
Imperfect.		*Imperfect.*	
Ich mußte, *ich mooss'-te*	I was obliged, etc.	Ich müßte, *ich muchss'-te*	(that) I were obliged, etc.
Du mußteſt,		Du müßteſt,	
Er mußte,		Er müßte,	
Wir mußten,		Wir müßten,	
Ihr mußtet,		Ihr müßtet,	
Sie mußten,		Sie müßten,	

Perfect Indicative.

Ich habe gemußt, I have been obliged.
ge-moosst'
Du haſt gemußt, etc., thou hast been obliged.

Perfect Subjunctive.

Ich habe gemußt, that I have been obliged.
Du habeſt gemußt, that thou hast been obliged, etc.

First Future Indicative.

Ich werde müſſen, I shall be obliged.
Du wirſt müſſen, thou wilt be obliged, etc.

First Future Subjunctive.

Ich werde müſſen, that I shall be obliged.
Du werdeſt müſſen, etc.

First Conditional.

Ich würde müſſen, I should be obliged.
Du würdeſt müſſen, thou wouldst be obliged.

Second Conditional.

Ich würde gemußt haben, I should have been obliged.
Du würdeſt gemußt haben, thou wouldst have been obliged, etc.

In this, and the other verbs of mood, the remaining persons of each tense are readily seen by a reference to the verb **haben**. From the nature of its meaning the verb can have no imperative mood, for you cannot command any one to be obliged to do a thing.

Examples of the employment of the Verb.

Sie werden laufen müſſen, They will be obliged to run; **Der Arzt mußte kommen**, The physician was obliged to come; **Er hat das Pferd verkaufen müſſen**, He has been obliged to sell the horse; **Warum habe ich das Geld ausgegeben? Ich habe gemußt**, Why have I spent the money? I have been obliged.

Dürfen, to be allowed, or to dare, has the general idea of permission granted or assumed: **Er durfte ausgehen**, He was allowed to go out; **Ich darf ſagen daß dieſer König ein Held war**, I may (venture, or be permitted to) say that this king was a hero. Sometimes the verb **dürfen** is employed in designating a doubt, something that may happen: for instance, **Wir wollen nicht bis zum November in England bleiben—es dürfte zu kalt werden**, We will not remain till November in England—it might become too cold.

INDICATIVE.	SUBJUNCTIVE.
Present Tense.	*Present Tense.*
Ich darf, I may (am allowed, *ich darrf* [dare)	Ich dürfe *ich duerr'-fe*
Du darfſt, thou mayest	Du dürfeſt
Er darf, he may	Er dürfe
Wir dürfen, we may	Wir dürfen
Ihr durfet (dürft), you may	Ihr dürfet
Sie dürfen, they may	Sie dürfen
Imperfect.	*Imperfect.*
Ich durfte, I might (was allowed) *ich doorrf'-te*	Ich dürfte *ich duerrf'-te*
Du durfteſt, etc.	du dürfteſt, etc.

Perfect Indicative.

Ich habe gedurft, I have been allowed, etc.
ge-doorft
Du haſt gedurft, etc.

Perfect Subjunctive.

Ich habe gedurft, that I have been allowed, etc.
Du habeſt gedurft, etc.

Pluperfect Indicative.

Ich hatte gedurft, I had been allowed.

Pluperfect Subjunctive.

Ich hätte gedurft.

First Future Indicative.

Ich werde dürfen, I shall be allowed, etc.
Du wirſt dürfen, etc.

First Future Subjunctive.

Ich werde dürfen
Du werdeſt dürfen.

Second Future Indicative.

Ich werde gedurft haben, I shall have been allowed.
Du wirſt gedurft haben.

Second Future Subjunctive.

Ich werde gedurft haben, that I have been
Du werdeſt gedurft haben. [allowed, etc.

First Conditional.

Ich würde dürfen, I should be allowed.

Second Conditional.

Ich würde gedürft haben, I should have been [allowed.

Examples: Das dürft Ihr nicht, das darf der Kaiſer nicht, That you may not (do), that may the emperor not (do)—Schiller's *Wilhelm Tell*. Ich durfte nicht ſprechen, I was not allowed to speak; Das Kind würde ausgehen dürfen, wenn es nicht ſo kalt wäre, The child would be allowed to go out, if it were not so cold: Wann werden wir das Vergnügen er warten dürfen Sie wieder bei uns zu ſehen? When shall we be able to (may we) expect the pleasure of seeing you in our house again? Er hat ſeinen Bruder nicht ſehen dürfen, He has not been allowed to see his brother (notice the omission of the zu, and the substitution of past participle for infinitive).

Können, to be able, corresponds in meaning to the English *can*, implying sometimes ability —Wir können dieſe Regel leicht verſtehen, we can easily understand this rule: or possibility in the past, present, or future—Auguſtus kann der nützlichſte der Römiſchen Kaiſer geweſen ſeyn, Augustus *may* have been the most useful of the Roman emperors. A third form is that in which a verb, such as to do, to speak, is understood—Könnte er nur immer, wie er wollte, Er ſchenkte Land und Leut an die Soldaten (Schiller's *Wallenstein*), Could he only always (do) as he liked, he would give land and people to the soldiers.

INDICATIVE.	SUBJUNCTIVE.
Present.	*Present.*
Ich kann, I can	Ich könne
Du kannſt, thou canst	Du könneſt
Er kann, he can	Er könne
Wir können, we can	Wir können
Ihr könnet (könnt), you can	Ihr könnet
Sie können, they can	Sie können
Imperfect.	*Imperfect.*
Ich konnte, I could	Ich könnte
Du konnteſt, thou couldst	Du könnteſt

Perfect Indicative.

Ich habe gekonnt, I have been able.
Du haſt gekonnt, thou hast been able, etc.

Perfect Subjunctive.

Ich habe gekonnt, that I have been able, etc.
Du habeſt gekonnt, etc.

Pluperfect Indictive.

Ich hatte gekonnt, I had been able.

Pluperfect Subjunctive.

Ich hätte gekonnt

First Future Indicative.

Ich werde können, I shall be able.
Du wirſt können, thou wilt be able, etc.

First Future Subjunctive.

Ich werde können.
Du werdeſt können, etc.

Second Future Indicative. [able.

Ich werde gekonnt haben, I shall have been
Du wirſt gekonnt haben, thou wilt have, etc.

Second Future Subjunctive.

Ich werde gekonnt haben.
Du wirſt gekonnt haben, etc.

First Conditional.

Ich würde können, I should be able, etc.

Second Conditional. [able, etc.

Ich würde gekonnt haben, I should have been

Examples: Wir wollen kommen, wann wir können, We will come when we can; Ich hatte es thun können, wenn er früher gekommen wäre, I could have done it, if he had come sooner; Ich ſage, er wird das nicht können, I say, he will not be able (to do) that; Er würde es nicht geben können, wenn er es nicht hätte, He would not be able to give it, if he had it not.

II.

MULTIPLICATION.

a multiplied by b is $a \times b$, which is generally written ab. The product of a, b, and c is abc. The order in which the quantities are written is indifferent; abc is the same as bac, etc. The product of two quantities is positive if the quantities multiplied have the same signs; negative, if they have different signs. Thus:

$$a \times b = ab; \quad -a \times b = -ab;$$
$$a \times -b = -ab; \quad -a \times -b = ab.$$

This is called the *Rule of Signs.**

If the quantities to be multiplied have numerical coefficients, these are multiplied as in arithmetic. Thus: $3x \times 5y = 15xy$; $4x \times -6y = -24xy$. The multiplication of powers of the same quantity is performed by adding the exponents. Thus $a \times a = a^2$, because the exponent of a is 1: $a^2 \times a^3 = a^5$.

The student will understand this clearly, if he writes out in full the powers he is about to multiply together. Thus $a^2 = a \times a$ and $a^3 = a \times a \times a$; and it is clear that the product of these is $a \times a \times a \times a \times a$, which we indicate by a^5.

From this rule for the multiplication of powers of the same quantity it follows that $a^6 \times a^{-4} = a^{6-4} = a^2$. We may ask what does a^{-4} mean; and we see that, if we are to give it a meaning at all, it must mean such a quantity as will, when multiplied into a^6, produce a^2. But it is clear that a^6 or $a \times a \times a \times a \times a \times a$ must be divided by a^4 or $a \times a \times a \times a$ in order to produce $a \times a$. Hence to multiply by a^{-4} according to the rule already given, produces the same result as if we had divided by a^4: in other words, that to multiply by a^{-4} is the same as to multiply by $\frac{1}{a^4}$; and we are thus led to interpret a^{-4} as meaning $\frac{1}{a^4}$; and, in general, that a^{-n} means $\frac{1}{a^n}$. The student knows from arithmetic that multiplying any number by $\frac{1}{p}$ will produce the same result as dividing that number by p. The meaning of a fractional exponent may be found in the same manner. For, by our rule for multiplication, $a^{\frac{1}{2}} \times a_{\frac{1}{2}} = {}^{\frac{1}{2}+\frac{1}{2}} = a$. $a^{\frac{1}{2}}$ then, must mean such a

* The proof of this rule is too long to be given here, but it can be seen in any large treatise on algebra.

quantity as will, when multiplied by itself, produce a; and this description of $a^{\frac{1}{2}}$ is just the definition of the square root of a. $a^{\frac{1}{2}}$, then, $= \sqrt{a}$. Similar reasoning leads us to conclude in general that $a^{\frac{1}{n}} = \sqrt[n]{a}$.

When the multiplier or multiplicand, or both, are compound expressions, we have the following cases :—

I. $(a+b) \times c$ or $(a+b)c$

$= (a+b)+(a+b)+(a+b) \ldots$ with $a+b$ written c times.

$= a+a+a+ \ldots$ with a written c times.
$\quad +b+b+b+ \ldots$ with b written c times.

$= ac+bc.$

II. $(a-b)c$

$= (a-b)+(a-b)+ \ldots$ with $a-b$ written c times.

$= a+a+a+ \ldots$ with a written c times.
$\quad -b-b-b- \ldots$ with $-b$ written c times.

$= ac-bc.$

III. $(a+b)(c+d)$

$= (a+b)+(a+b)+(a+b) \ldots$ with $(a+b)$ written $(c+d)$ times.

$= a+a+a+ \ldots$ with a written $(c+d)$ times.
$\quad +b+b+b+ \ldots$ with b written $(c+d)$ times.

$= a(c+d)+b(c+d).$

$= ac+ad+bc+bd.$

IV. $(a-b)(c+d)$

$= (a-b)+(a-b)+(a-b) \ldots$ with $(a-b)$ written $c+d$ times.

$= a+a+a+ \ldots$ with a written $(c+d)$ times.
$\quad -b-b-b- \ldots$ with $-b$ written $(c+d)$ times.

$= a(c+d)-b(c+d).$

$= ac+ad-bc-bd.$

V. $(a-b)(c-d)$

$= (a-b)+(a-b)+ \ldots$ with $(a-b)$ written $(c-d)$ times.

$= a+a+a+ \ldots$ with a written $(c-d)$ times.
$\quad -b-b-b- \ldots$ with $-b$ written $(c-d)$ times.

$= a(c-d)-b(c-d).$

$= ac-ad-bc+bd.$

If we examine the results in each of these cases, we see that they consist of the sum of the products of each term of the one factor, multiplied by each term of the other factor. We should find the same to hold true if there were three or more terms in either or both factors. Hence the rule for multiplication when either or both of the factors is a compound expression. Multiply each term of the one factor by every term of the other factor, and set down the products so obtained with their proper signs—according to the *Rule of Signs*.

The following are examples of the way multiplication is generally worked.

(1) $x+3$
$\quad y+9$

$xy+3y$ = product of $x+3$ by y.
$\quad 9x+27$ = product of $x+3$ by 9.

$xy+9x+3y+27$ = complete product.

The convenience of shifting the second product to the right will be seen hereafter. It is only a matter of convenience, and is not essential to the correctness of the operation.

(2) Multiply $a+b$
into $a+b$

a^2+ab the product by a.
$\quad ab+b^2$ the product by b.

$a^2+2ab+b^2$ the product by $a+b$.

(3) Multiply $a+b+c$ into $a+b-c$.

$a+b+c$
$a+b-c$

$a^2+ab+ac$ the product by a.
$\quad ab+b^2+bc$ the product by b.
$\quad -ac-bc-c^2$ the product by $-c$.

$a^2+2ab+b^2-c^2$.

(4) Multiply together $a-b$, $a-c$, $a-d$.

$a-b$
$a-c$

a^2-ab
$\quad -ac+bc$

$a^2-ab-ac+bc$ the product of $a-b$ and $a-c$.
$a-d$

$a^3-a^2b-a^2c+abc$
$\quad -a^2d+abd+acd-bdc.$

$a^3-a^2b-a^2c-a^2d+abc+abd+acd-bdc.$

(5) Multiply together a^m+b^n and a^m-b^n.

a^m+b^n
a^m-b^n

$a^{2m}+a^mb^n$
$\quad -a^mb^n-b^{2n}$

$a^{2m} \quad -b^{2n}$

Examples.

Multiply together :

1. $16ab$ and $4c$. Ans. $64abc$.
2. $33xy$ and $-5a$. Ans. $-165axy$.
3. $12a^2$ and $6a^2$. Ans. $72a^4$.
4. $25m^n$ and $14n^m$. Ans. $350m^nn^m$.
5. a^{-m} and a^n. Ans. a^{-m+n}.
6. $(a+x)^{-\frac{3}{5}}$ and $(a+x)^{\frac{4}{7}}$. Ans. $(a+x)^{-\frac{1}{35}}$.
7. $a^{-3}x^{\frac{1}{2}}y^{\frac{1}{2}}z$ and $a^2x^{-1}y^{-3}z^{-1}$. Ans. $a^{-1}x^{-\frac{1}{2}}y$.
8. $-17a^2b^mc^{-1}$ and $12a^{-2}b^nc$. Ans. $-204b^{m+n}$.
9. $3ab+6x+3y$ and $4a$. Ans. $12a^2b+24ax+12ay$.
10. $6ab-4x^2-6z$ and $4ab$. Ans. $30a^2b^2-20abx^2-30abz$.
11. $6ax+7m-5q$ and $3y$. Ans. $18axy+21my-15qy$.
12. $12a^{-1}+b^{-2}-30x^9$ and $2a^{-\frac{1}{2}}$. Ans. $24a^{-\frac{3}{2}}+2a^{-\frac{1}{2}}b^{-2}60a^{-\frac{1}{2}}x^9$.
13. $a^2+x^2b-y^2$ and $a-b$. Ans. $a^3+ax^2b-a^2b-x^2b^2+by^2-ay^2$.
14. $a^3+a^2b+ab^2+b^3$ and $a-b$. Ans. a^4-b^4.
15. a^2+b^2 and a^2-b^2. Ans. a^4-b^4.
16. x^2+xy+y^2 and x^2-xy+y^2. Ans. $x^4+x^2y^2+y^4$.
17. $2a^2-3ax+4x^2$ and $5a^2-6ax-2x^4$. Ans. $10a^4-27a^3x+34a^2x^2-18ax^3-8x^4$.

18. $3a-2b+2c$ and $2a-4b+5c$.
Ans. $6a^2-16ab+19ac+8b^2-18bc+10c^2$.
19. $x^2+10xy+7$ and $x^2-6xy+4$.
Ans. $x^4+4x^3y+11x^2+60x^2y^2-2xy+28$.
20. x^3+x^2+x+1 and $x-1$. Ans. x^4-1.
21. x^2-ax+b and $x+c$.
Ans. $x^3-ax^2+cx^2+bx-acx+bc$.
22. $7a^5x^5+a^5y^4$ and $7a^5x^5+a^4y^5$.
Ans. $49a^{10}x^{10}+7a^{10}x^5y^4+7a^9x^5y^5+a^9y^9$.
23. $21a^x+3b^y$ and $21a^x-3b^y$.
Ans. $441x^{2x}-9b^{2y}$.
24. $a^nb^n+a^n$ and $a^nb^n-a^n$. Ans. $a^{2n}b^{2n}-a^{2n}$.
25. $a-bx^3$ and $c-dx^3$.
Ans. $ac-adx^3-bcx^3+bdx^6$.
26. $a^x+a^{2y}+a^z$ and $a^x-a^{2y}+a^z$.
Ans. $a^{2x}+2a^{x+z}-a^{4y}+a^{2z}$.
27. $pa^m-qa^n-ra^y$ and $pa^m-2qa^n-3ra^y$.
Ans. $-3pqa^{m+n}-4pra^{m+1}+5qra^{n+y}+p^2a^{2m}+2q^2a^{2n}+3r^2a^2y$.

little later France, England, a large part of Germany, Austria, and Russia, besides western Asia and northern Africa, were formed into Roman provinces, and ruled by Roman governors according to Roman laws. And as the huge fabric fell to pieces again, the nations of modern Europe, or at all events those of the west and south, were gradually formed out of its fragments, and their civilization was impressed with the Roman stamp. So that it is impossible to thoroughly understand the history of any modern European nation without knowing a good deal about that great empire which once embraced them all, and has left its mark on them to this day. On some this mark was not so deep as on others. Thus the Germans of the north and the Russians of the north-east felt the Roman influence but slightly; and in England Roman civilization was overwhelmed

Importance of Roman history.

ROME UNDER THE KINGS.

XLI.

Rome.

It is not too much to say that the history of Rome is, to Europeans, the most important of all histories. In fact, it comprises the early history of the greater part of Europe and considerable parts of Asia and Africa for more than two thousand years. The ancient world was absorbed into the Roman empire, and the modern world grew out of it. Nearly two centuries before the Christian era all the countries which border the Mediterranean had been absorbed into the Roman empire; and a and almost effaced by the barbarian Saxons, who poured in as soon as the Roman garrisons were withdrawn. But even outside the borders of the Roman empire her indirect influence was enormous, and must be taken into account in studying the history of her neighbours.

It is worthy of remark that Rome is the name of a single town, not of a nation, nor even a province; and that the mighty empire was ruled by the citizens of this one town, to the exclusion of all the other millions who were in fact the subjects of Rome. It is true that as the empire grew many citizens of other Italian towns, and in the end all her subjects, were made citizens of Rome and allowed equal privileges. But this was done very gradually, and after many centuries; and moreover, the chief political privileges of a citizen could only

Citizens of Rome.

be exercised personally at Rome, so that all political power really remained in the hands of the inhabitants of the city of Rome.

This wonderful city of Rome—and it is still the most wonderful and interesting city perhaps in the world—is situated about half way between the two extremities of Italy, on the banks of the river Tiber, about fifteen miles from the sea. It is said to have been founded in the year 753 before Christ, being intended as a military colony or outpost of the Latins, to guard the passage of the river against the Etruscans, who lived north of it. At this time Italy was peopled by several distinct races of men. There were the Gauls in the far north, between the Alps and Apennines; then came the Etruscans, occupying the west coast almost up to the Tiber; and then the Italians, including the Latins. In the extreme south there were several rich Greek colonies. These different races were at constant war with each other; and Rome was one of many Latin strongholds along the Tiber, which were much needed to keep off the stronger and more civilized Etruscans. There is a tradition about the founding of Rome, which, though not to be treated as a historical fact, is yet worth knowing, and was no doubt believed by the Roman people. Amulius having deposed his brother, the king of Alba Longa, and put the king's sons to death, made himself king. But a daughter of the deposed king had twin sons by the god Mars. Romulus and Remus were their names. Amulius had them thrown into the Tiber, and its rapid stream soon carried them out of sight, but instead of drowning them, miraculously bore them to the shore and cast them up on the dry land where Rome now stands. A she-wolf gave them suck, until a shepherd found them and took them to his hut and brought them up. When they were grown up their parentage became known; they slew their wicked uncle, and replaced their grandfather on his throne. Then the brothers built a city on the place where the wolf had found them. They quarrelled over its name. Remus provoked Romulus, who thereupon slew his royal brother, and called the city Rome after himself. After a warlike reign he disappeared, being taken up to heaven by his father Mars, and the people built a temple in his honour and worshipped him as a god. He was succeeded by other kings, concerning whom there are traditions, but no trustworthy historical accounts. It is certain, however, that at a very early period in her existence Rome was governed by kings, and that she rapidly rose to be the head of the Latin cities. There was a "senate" or council of *old men* (Lat. *senex* = an old man), who were the heads of the old original families: "patres," *i.e.* fathers, these heads of families were called, and the king was their president. But other people came from neighbouring states to settle in Rome, and they were allowed no voice in the senate. The "patres" despised them as foreigners, and called them the "plebes" or crowd. As time went on, the *patricians* or descendants of the "patres" became an order of nobles, who kept all power in their own hands, while the "plebes" (or *plebeians*) formed the mass of the nation, and had no voice in the government, and were harshly treated by the patricians. The last three kings tried to gain some share of government for the people, but without much success; and we shall see what a long and resolute struggle the plebeians had to maintain before they won their fair share.

The city of Rome.

Inhabitants of Italy.

Tradition of the founding of Rome, B.C. 753.

Early form of government.

Patricians and Plebeians.

The government by kings came to an end, it is supposed, in the year 509 B.C.—Tradition says that once while the Roman army was besieging a neighbouring town the king's sons and their cousin Collatinus were carousing together, and the conversation turned on their wives. In order to settle the dispute as to which of the wives was the most virtuous, the young men took horse to visit them unexpectedly and see how they were each engaged. The wives of the young Tarquins were found amusing themselves with frivolous gaieties, but Lucretia the wife of Collatinus was busy among her maids spinning. The prize of virtue was unhesitatingly accorded to her, and the young men departed. But Sextus, one of the young Tarquins, was so taken by the beauty of Lucretia that in the evening he returned and claimed shelter for the night, which, as her husband's friend, was readily granted. In the night he entered her chamber, sword in hand, and threatened to kill her unless she submitted to his will; but she would not yield. Then he swore he would not only kill her but would also kill his own slave and lay his dead body in the bed beside hers. To save her own and her husband's reputation from such a foul slander, she at last submitted. But next morning she called together her husband and kinsmen and told them what had occurred. Then bidding them avenge her disgrace she plunged a dagger into her heart and expired. Her kinsman, Brutus, taking the bloody dagger from her body, swore on it that he would be avenged on the whole race of Tarquin. The kinsmen hurried to Rome and told their story. The people, roused to fury by such a tale of horror, at once decreed that Tarquin and his family should be expelled from the city and that there should be no more kings of Rome.

Legend of Lucretia.

End of the kingly government.

One other tradition, coming down from the time of the kings, is worth relating. One day there came a strange woman, who demanded to see the king, Tarquinius. She carried nine large volumes. These she offered to the king for a great price. He declined to buy them. The woman went away, but after burning three returned soon with six of the same volumes, and offered the six for the same price that she had first named for the nine. His curiosity was roused, but still he declined to purchase. She went away again, but after burning three others, returned the third time with the remaining three, and still demanded

The Sibyline Books.

for these three the original price. Struck by her strange conduct and weird supernatural look, the king now boughtt he books. Then the woman disappeared. She was believed to be the Sibyl of Cumæ, a witch or prophetess who lived at Cumæ, near Naples, and was supposed to be inspired, like the oracles of Greece. The books were called the *Sybiline Books*, and were believed to contain prophecies concerning the future destinies of Rome. They were carefully guarded and consulted for centuries in times of national danger or perplexity, until they were burned accidentally in a great fire, B.C. 83.

The Romans, having driven out their kings, elected a *Dictator*, who had all the powers of a king, but only for a year; just as the Athenians, when they got rid of their kings, elected an Archon with kingly power, at first for life, then for a term of ten years, which they afterwards cut down to one year. Again like the Athenians, they found that to commit absolute power to one man for even a year was not good, and so they divided the power equally between two men, whom they at first called *Prætors*, *i.e.* leaders, and afterwards *Consuls*, *i.e.* deliberators. The office of dictator was only filled in great emergencies, when the senate believed it necessary for the safety of the state to concentrate for six months all the power in one man's hands. We shall meet with many such occasions all through the history of the republic.

New forms of government.

The expulsion of the kings was followed by attacks from various neighbours, some of them wishing to restore Tarquinius, and others thinking it a good opportunity for ravaging the Roman territory while affairs were in confusion. In these attacks the poorer plebeians suffered most, their farms being exposed to the enemy's raids, and they themselves obliged to serve in the army without wages, besides having to pay taxes. At the end of the war great numbers of them were deeply in debt to wealthy patricians, and had no prospect of being able to pay. Now, in Rome, as in Greece, a debtor who was unable to discharge his debt became the property of his creditor, who could use him as a slave and even sell him into slavery. This law gave the patricians immense power over the plebeians, and they were not slow to use it for their own advantage. The whole order of plebeians was much oppressed, until at last they determined to bear it no longer. So they left Rome in a body, and encamped on a hill three miles outside; and to all appearance a great civil war was about to commence. But the patricians were too wise to risk this, and so they sent ten of their number to persuade the plebeians to return. One of these was a wise man, who hit on the happy idea of explaining the situation by means of a fable. Once upon a time, he told them, the other members of the body mutinied against the belly, and refused to work for it. They complained that it was quite unfair that while they had to fetch and carry for it, it did nothing but enjoy itself; and so they would give it no more food. But to their dismay they found that while they starved the belly they themselves got weak and gradually wasted away. So would it be with the plebeians if they tried to starve out the patricians. The plebeians saw the truth of the fable, and agreed to return and work for the patricians again, but only on condition that some guarantee was given that they would not be unjustly oppressed. To secure this they insisted on having officers appointed by themselves, who should have power to protect them. The patricians consented, and two plebeians were appointed *Tribunes*, with power to deliver any man from the magistrates. Their houses were to be always open as a refuge for the oppressed, and their persons were to be sacred, so that any one who should even attempt to strike or injure them was to be outlawed. Thus the authority of the patrician rulers, though not taken away, was checked by that of the tribunes; and, as might be expected, many collisions took place between the authority of these two sets of rulers. But from this time forth the patricians could not have everything their own way, for even the decrees of the senate could be rendered null and void by the veto of the tribunes of the people. It is instructive to observe that this great revolution, by which the patricians lost so much of their power, was carried out without any bloodshed or civil war. It proves, what is abundantly shown all through Roman history, that her rulers had that grand element of political wisdom, the knowing when to yield to the demands of the growing spirit of liberty and justice in the people. And it proves also that on the side of the people there was a spirit of moderation and patience, relying on justice and reason rather than on passion and force. No other people that we know of in ancient or modern times, unless it be our own countrymen, have shown these qualities in such a high degree in rulers and ruled; and there can be no doubt that to this quality is chiefly due the success which both we and they have achieved in building up a great empire.

Distress of the plebeians.

They leave the city.

Concessions to them.

Tribunes.

Moderation of both parties.

XLIV.

Parallax of Stars.—Star Clusters.

Reference has already been made to the parallax of the stars, this parallax being the angle subtended by the radius of the earth's orbit at the distance of the star. The parallax of a number of stars has been determined with some approach to accuracy, though the work is one of excessive difficulty on account of the exceeding

Annual parallax of stars.

minuteness of the parallax of the stars. One second of arc is a very minute quantity, but a parallax of 1″ would show that a star was at the enormous distance of twenty millions of millions of miles, or over two hundred thousand times as far away as the sun,—a distance so immense that even light, travelling as it does with such great velocity, would require some three years to traverse it. Yet no star has been discovered to have so great a parallax as a whole second of arc, the greatest known parallax, that of α Centauri, being only 0·95″.

The stars whose parallax is best known appear to be the following :—

34 Groombridge	8th mag.	Parallax	= 0·31″
η Cassiopeiæ	4th mag.	,,	= 0·15″
μ Cassiopeiæ	6th mag.	,,	= 0·34″
α Aurigæ	1st mag.	,,	= 0·30″
Sirius	1st mag.	,,	= 0·25″
Procyon	1st mag.	,,	= 0·12″
Weisse Bessel, 112	8th mag.	,,	= 0·50″
β Centauri	1st mag.	,,	= 0·28″
Arcturus	1st mag.	,,	= 0·13″
α Centauri	1st mag.	,,	= 0·95″
73 Ophiuchi	4th mag.	,,	= 0·16″
α Lyræ	1st mag.	,,	= 0·18″
σ Draconis	5th mag.	,,	= 0·24″
61 Cygni	5½th mag.	,,	= 0·50″

From this list it is evident that many of the first magnitude stars have annual parallaxes of about one-fifth of a second. A sufficient number of these parallaxes have not as yet been determined to enable it to be ascertained whether they show the same law as the proper motions, and indicate that though many of the fainter stars may be nearer to us than those brighter, yet that, considering them as a whole, the average distance of the fainter stars is greater than the average distance of the brighter ones.

FIG. 99.—CLUSTER 3 M IN CANES VENATICI.

From some photometric measurements which have been made it would seem that the average brightness of a star of the first magnitude is about ten thousand millionths of the brightness of the sun. If therefore the sun was transported from us to even the average distance of a star of the first magnitude it should shine like a comparatively insignificant star, so that it is far from being one of the brighter luminaries of the stellar host. From the knowledge we have gained of the masses of the binary stars whose parallax has been determined, it would seem that most of the stars have masses of from three to ten times as great as that of our sun.

Masses of the stars.

Some of the most remarkable features in the heavens are presented by the great clusters of stars which have been discovered in different portions of the heavens. In small telescopes and with low powers these clusters of stars cannot be distinguished in appearance from the nebulæ, but in larger telescopes and under higher powers their true nature becomes apparent, many of them being resolved into clusters of thousands of minute stars. For this reason it was at one time believed that all the nebulæ were merely clusters of stars, only that some were too far off for them to be resolved into stars even in the finest instruments. The spectroscope has shown, however, that many of these supposed irresolvable clusters of stars are really masses of glowing gas, and apparently entirely different in character from the star clusters.

Star clusters.

The real character of these clusters of stars is still uncertain: they may be merely great groups of stars which are much closer to each other than is commonly the case, and hence appear all clustering together; or they may be great systems of suns, all moving round their common centre of gravity, and much more intimately connected with each other than is commonly the case with different stars in the universe. The tendency in many cases for these stars to have the same magnitude, or to be commonly of some one magnitude but grouped round one or more larger stars, would seem to favour the idea that they were really systems of stars all closely grouped together under some physical link. And though the term "close" is here used, it must only be understood in a relative sense; the stars may seem to be only a few tenths of a second apart, but these few tenths of a second probably correspond to many hundred or even thousand times the distance of the earth from the sun.

Systems of stars.

In small telescopes, or in larger telescopes under small magnifying power, these clusters appear like dull spots of cloudy light, indistinguishable from the true nebulæ; but when the telescope is of adequate aperture, as the magnifying power is increased these cloudy spots of light begin to change in character. They commence to sparkle as it were, minute glittering specks can be detected as if the whole were strewn with diamond dust; and as higher powers are used, the whole gradually resolves itself into thousands of glittering points of light, and they are visible in their true character as great clusters of minute brilliant stars. In some cases this resolution into stars only occurs in the finest telescopes; but in a great number of cases even telescopes of moderate power will resolve these clusters into grand groups of very minute glittering stars, usually of from the 10th to the 14th standard magnitude.

Telescopic appearance.

The following is a list of the more interesting of these clusters. In it the letter M stands for Messier, and shows that the number following is the number in Messier's original Catalogues of Nebulæ and Clusters. A number without a letter is the number of the cluster in Sir John Herschel's great Catalogue of Nebulæ and Clusters.

List of star clusters.

M 37. R. A. = $5^h\,44^m$. Dec. = $+32°\,22'$. In Aurigæ. A grand cluster of nearly a thousand yellowish stars, principally of the 11th and 12th mag.; many apparently arranged in streams and festoons.

M 35. R. A. = $6^h\,1^m$. Dec. = $+24°\,21'$. In Geminorum near ϵ. A mass of small stars of all magnitudes, with a diameter of about 20′, and forming a gorgeous object in large telescopes.

M 41. R. A. = $6^h\,42^m$. Dec. = $-20°\,37'$. In Canis Major, 4° south of *Sirius*. A fine group with a reddish star near the centre.

M. 44. R. A. = $8^h\,33^m$. Dec. = $+20°\,22'$. In Cancer. The "Præsepe" of the ancients, being visible to the naked eye as a mass of minute stars.

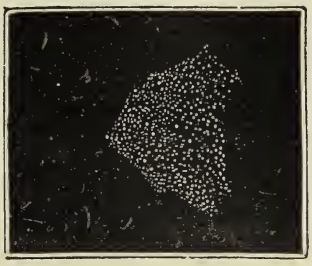


FIG. 100.—CLUSTER 35 M IN GEMINI.

M 51. R. A. = $13^h\,25^m$. Dec. = $+47°\,29'$. In Canes Venatici. The so-called spiral nebula. In ordinary telescopes resembles a dull misty spot, a little brighter towards one edge; but in Lord Rosse's great telescope seems to have a wonderful spiral structure. Might have been supposed to have been a real gaseous nebula, but, according to the spectroscope, consists of excessively minute stars. This, however, is not conclusive in such a case, for the reason given under 31 M.

M 3. R. A. = $13^h\,37^m$. Dec. = $+28°\,58'$. A great mass of minute stars, mainly 11th and 12th mag., forming a grand globular cluster.

FIG. 101.—51 M IN CANES VENATICI. THE SPIRAL NEBULA.

M 80. R. A. = $16^h\,10^m$. Dec. = $-22°\,42'$. Half-way between α and β Scorpii. Under low powers resembles a comet in appearance, but easily resolved into a grand mass of 12th mag. stars. Within it appeared in 1860 a temporary star, blazing up to the 7th mag., and then rapidly fading away until no longer distinguishable.

M 13. R. A. = $16^h\,37^m$. Dec. = $+36°\,41'$. The great cluster of Hercules, lying about one-third of the way from η towards ζ. A magnificent cluster easily resolved by any telescope of greater aperture than six inches. In large instruments seems to consist of a great globular cluster of many thousand stars, ranging from the 10th to the 14th mag., even if not beyond. It is traversed by several dark rifts or markings.

M 92. R. A. = $17^h\,13^m$. Dec. = $+43°\,16'$. A fine cluster, also in Hercules, of similar character to the last, but seems to consist of brighter stars more closely packed, so that it is not so easily resolved. Towards the centre it is very bright, indicating its globular form.

M 22. R. A. = $18^h\,29^m$. Dec. = $-34°\,0'$. Between μ and σ Sagittarius. A fine but coarse cluster, principally of 10th *and* 13th mag. stars, with but few of intermediate brightness. It is bright and easily resolved.

M 15. R. A. = $21^h\,24^m$. Dec. = $+11°\,38'$. North-west of ϵ Pegasi. A bright cluster of 12th mag. stars, easily resolved, and very bright in the centre.

M 2. R. A. = $21^h\,27^m$. Dec. = $-1°\,22'$. In Aquarius, north of β. A fine round nebulous object about 5′ in diameter, consisting of a globular cluster of innumerable 13th mag. stars.

M 30. R. A. = $21^h\,34^m$. Dec. = $-23°\,42'$. In Capricornus. A moderately bright nebulous cluster, resolvable into innumerable 12th mag. stars. Close to it is an 8th mag. star forming a fine contrast.

To the above perhaps may be added the following, whose exact nature is uncertain; for whereas it possesses all the appearance of being a true nebula, yet its spectrum would appear to be continuous, indicating it to be rather an enormous cluster of excessively minute stars very closely condensed:—

M 31. R. A. = $0^h\,26^m$. Dec. = $+40°\,35'$. The great nebula of Andromeda, readily visible to the naked eye as a dull spot of light close to ν Andromeda, and nearly half-way between α and γ. It appears like a long oval mass of light, bright towards the centre and gradually fading away on all sides; near it are a considerable number of very faint stars, and traversing it have been seen several dark rifts. Its whole appearance is that of a nebula, perhaps a mass of gas so condensed that its spectrum is continuous, and not, as usual, one composed of bright lines. The possibility of this always renders it difficult to be sure whether a body of this character is gaseous or not.

Such is one of the problems of a science which offers to the observer more wonders perhaps than any other study that could be named.

XVII.

Centres or Mean Points (*continued*).

§ 74. The utility of a mass-centre may now be noticed. For many of the applications thereof we may refer our readers to Clerk Maxwell's little book on "Matter and Motion."*

* A book to the matter and motion of which our readers are deeply indebted.

There is, however, one most important application which may here be specified. A reference to fig. 40 (p. 545),—supposed to be completed as described in the text,—will show that if three forces be represented in magnitude and direction by A P, B P, C P, their resultant is given by D P or 3 O P; for the lines A P, B P, C P, and P D added together make a closed figure, so that the forces would be in equilibrium (§§ 45, 46); or D P is the resultant of A P, B P, C P. Now, suppose that P instead of being near, as in fig. 40, is some distance away. In this case the lines A P, B P, C P, O P become so nearly equal and parallel, that it is impossible to detect the difference. To all intents and purposes A P, B P, C P will represent parallel and equal forces; and we learn that the resultant of such forces always passes through the mass-centre of the particles.

Application.

The suppositions we have been making are realized in the case of weight. We know that bodies of equal mass have equal weight. Moreover, the directions of the weights of the particles of a body are indistinguishable from parallels. Hence it appears that the resultant of all these weights—or, say, the weight of the body—acts in a line which passes through the mass-centre of the body. If then by any means we can find the mass-centre of a body, we know its "weight-line" in any position; for the weight-line is a vertical line through the mass-centre. On account of this property, the mass-centre is often called the weight-centre or centre of gravity. But it is well to distinguish between the two things, just as we have had to distinguish between mass and weight. In the following sections, then, we shall discuss what may be called force-centres, which are indeed only what are commonly known as the "points of application" of forces.

Weight lines.

§ 75. An illustration affords probably the best means of explaining what is meant by a force-centre. If we have a piece of iron embedded in a block of wood, and bring a magnet near, we shall come to the conclusion that the action of the magnet is almost exclusively upon the iron, and that the attraction of the wood by the magnet is inappreciable. We consider the action of the force as taking place at *a certain point* in its line of action. Such a point as this is a "point of application" of the force, or the force-centre of a system of forces. When we come to examine the grounds upon which we select one special point in the line of action of the force, it appears that this determination is based upon at least two distinct experiments, in which the force acts upon the body in different positions. Suppose the piece of iron in the block of wood above mentioned is entirely surrounded by the wood, so as to be out of sight, and that we wish to determine its position by the help of a powerful magnet, we may proceed in this fashion: Suppose a piece of string, one end of which is tied to a fixed body, and its other end is attached to the block. We will also assume that measures have been taken to neutralize the weight and other forces that act on the block (for instance, by floating it in a liquid in which it neither sinks nor floats). On the approach of the magnet the string will become taut, and when the block comes to rest the string points in the direction of the piece of iron; because the two forces that act on the block, and keep it at rest, must be in the same straight line. But from this experiment we learn nothing as to the whereabouts of the iron in this line. To discover this we must attach the string to another part of the block, and repeat the experiment. This gives us another line, in which the iron must be; and manifestly the iron is actually at the meeting-point of the two lines. Having once determined the place of the iron, we can determine at once the direction the string will take when it is fastened to any proposed point on the block: it will be the continuation of the straight line.

Force-centre.

Illustration.

By experiments of just the same kind we may find the centre of any system of forces, if one there be. The most common case is that of the weight of a body. The weight-centre or centre of gravity may be found by suspending a body first from one point and then from another. The prolongation of the line of the suspending cord passes through the centre of gravity, and the intersection of the two lines is the centre we seek.

Centre of gravity.

§ 76. It is worth while to notice the distinction between the two centres of which we have been speaking. They are determined, it will be observed, by methods which are fundamentally different. The mass-centre is found without any direct reference to forces; and the only indirect allusion to force is in the measurement of masses, which may be considered to depend upon a comparison of forces *as to magnitude*. The force-centre, on the other hand, is determined by at least two experiments in which the *direction* of the force is changed with respect to the body. Again, while every body, or group of bodies, has a mass-centre, it is only few bodies that have a weight-centre. The lines of action of the force in different experiments do *not* intersect. It is true that in the case of a heavy body on the earth's surface, the direction lines pass so near to one another that a proof of the error is utterly beyond our present powers of experiment. But in astronomy we get evidence of it. For the curious wobble of the earth called nutation is due to the fact that it has not a weight-centre.

Comparison.

It is customary in works upon mechanics to state that a force is defined by three characters —its magnitude, its line of action, and its point of application. This done the reader is introduced to the principle of Transmissibility of Force, which is that a force may be supposed to act at *any* point in its line of action; so that the "point of application" is immediately ignored. To us it has seemed better to start with the simple characters of a force—its magnitude and line of action, and to postpone the question of the "point of application"; partl because of the complexity of the idea (since no single observation will determine from the iron particle to the point of attachment

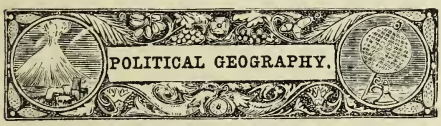
Attack.

And Defence.

this point), partly with the view of indicating the intimate connection between the point of application of a force and centres of gravity properly so called.

Here we must conclude our brief notes upon Mechanics. May we express a hope that some of our readers, at least, will find themselves sufficiently interested to pursue the study for themselves?

END OF "MECHANICS."



XI.

ASIA.

ASIA, the original seat of the human race, and the region where civilization, arts, and commerce first took their rise, is the largest of the great divisions of the earth. It constitutes the north-eastern portion of that great mass of land known as the Old Continent, of which Europe forms the north-western and Africa the south-western portions. Asia exceeds in size both Europe and Africa together, and comprises about a third of the entire land surface of the globe, or more than 17,000,000 square miles. It extends from lat. 1° 20′ N., or including the islands of the Indian Archipelago from 11° S. to 78° N., and from long. 26° to 190° E.; being bounded north by the Arctic Ocean, east by the Pacific Ocean, south by the Indian Ocean, and west by the Red Sea and a line drawn across the Isthmus of Suez, which separates it from Africa, and by the Mediterranean Sea, the Sea of Marmora, Black Sea, range of the Caucasus, Caspian Sea, Ural river and mountains, and river Kara, which separate it from Europe. Its greatest length, from the Isthmus of Suez to Behring Strait in the north-east, is about 6,700 miles; and its greatest breadth, from Cape Chelyuskin in the north, to the southern extremity of the Malayan peninsula in the south, 5,300 miles. The coasts are deeply indented with seas, gulfs, and bays; the principal of which are the Gulf of Obi, in the north; the Gulf of Anadir, Sea of Okhotsk, Gulf of Tartary, Sea of Japan, Yellow Sea, and Gulf of Tonquin, in the east; and the Gulf of Siam, Bay of Bengal, Arabian Sea, and Persian Gulf, in the south. The principal Asiatic peninsulas are Arabia, India, the Eastern Peninsula, Corea, and Kamtschatka. The coast-line is estimated at about 35,000 miles in length.

The surface is for the most part flat, although it sometimes rises to a great elevation. A great mass of mountain and table-land extends through the whole continent from the Mediterranean in the south-west to Behring Strait in the north-east. The whole region lying to the north and north-west of this, including the whole of Siberia, is a vast plain from 200 to 1,200 feet above the sea. The southern portion of Asia lying along the shores of the Indian Ocean is in general low and flat. The principal mountain ranges consist of four great chains running nearly parallel to each other from west to east. The furthest south is the Himalaya range, which extends, in general, from north-west to south-east, and consists of three parts,—the Hindoo Koosh, which extends from the mountains of Afghanistan to Cashmere; the Himalayas Proper; and the mountains of Bhotan and Assam. The entire length of the range is about 1,800 miles, and its average height from 16,000 to 20,000 feet, while its loftiest summit, Mount Everest, which is also the highest in the world, rises to 29,002 feet. The Kuen-Lun Mountains run nearly parallel to the Himalayas, and are continued, under various names, westward to the shores of the Caspian and Black Seas, finally terminating on the south-western shore of the latter. They extend eastward to about the hundredth degree of east longitude. North of the Kuen-Lun, and stretching in the same direction, are the Thian-Shan, or Celestial Mountains, rising from the plains of Turkestan, and extending eastward along the forty-second parallel of north latitude, as far as the great Desert of Gobi. The highest summit of this range is the Bogdo Oola, or Holy Mountain, which rises above the line of perpetual snow. The Altai range extends along the south of Siberia, from near the confluence of the Bukhtarma and Irtish to Mount Gurbi, south of Lake Baikal; but its continuations and branches stretch, under various names, as far as the Sea of Okhotsk and the East Cape. The principal of the other mountains of Asia are the Ural Mountains and the Caucasus, which separate it from Europe, the Taurus in Asia Minor, the Persian Mountains, the Ghauts and the Vindhaya Mountains in India, and the Mountains of Mongolia. The great rivers of Asia flow northward, eastward, and southward from the great central highlands. Of those that flow northward into the Arctic Ocean, the principal are the Obi, with its tributary the Irtish, which has for affluents the Ishim and Tobol; the Yenisei, with its affluent the Angara, and the Lena, which receives the Aldan. These are among the largest rivers of Asia, the Obi being about 2,500 and the Yenisei 2,700 miles in length. Flowing eastward into the Pacific Ocean are the Amoor, the Hoang-ho or Yellow River, and the Yang-tse-kiang or Blue River. The last is commonly reckoned the longest river of Asia, its winding course being estimated at about 3,000 miles in length. The principal streams running southward are the Mekong, or Cambodia, and the Meinam, which fall into the Chinese Sea; and the Salwen, Irawady, Brahmápūtra, Ganges, Godavery, Krishna, Nerbudda, Indus, and Euphrates, which fall into the Indian Ocean. Asia does not contain so many lakes as Europe, but some of them are of great size. The Caspian Sea, the largest inland sea or lake in the world, has an area of about 18,000 square miles, and the Sea of Aral about 3,400 square miles. These are believed to be the remains of a great inland sea which at one time existed here, and covered a large tract of country still considerably below the level of the sea. The surface of the Caspian is now about

eighty-four feet below the level of the waters of the Mediterranean. The principal of the other lakes are Lake Tengiz or Balkash, in Turkestan, and Lake Baikal in Siberia. Asia possesses every variety of climate, from the extreme heat of the torrid zone to the intense and long-continued cold of the Arctic regions. Most of the continent, however, is within the temperate zone. Only the southern promontories and islands fall within the tropical region, and only the northern borders of Siberia are within the Arctic one. Regarded as a whole, the climate of Asia may be classed under three divisions,—that of Siberia in the north, of the highlands in the centre, and of India and the other parts in the south. In the north the winters are long and severe, with short summers characterised by excessive heat. In the highlands of the interior the climate is cold and dry, exposed to piercing winds from the north, with little or no rain, so that the region presents mostly bare steppes and sandy deserts. In the countries lying south of the highlands the climate is characterised by great heat and abundance of moisture. The heat of summer is intense, and there is no real winter, but at particular seasons of the year the rain falls with great violence. Although Asia presents large tracts of extreme fertility, yet a great part of the continent consists of immense sandy deserts, steppes, and morasses. The largest of these is the Desert of Gobi or Shamo, 1,400 miles in length by from 500 to 700 in breadth. The plain of Iran, in Persia, which covers an area of 500,000 square miles, is little better than a sandy desert; and the table-land of Tibet, 800,000 square miles in area, is a barren steppe. The plain of Siberia is mostly a frozen morass in the north, while in the south it assumes the character of steppes, producing a coarse kind of herbage. In China, the Eastern Peninsula, and the greater part of Hindostan, the country is extremely fertile. The principal plants raised for food in India and the eastern countries of Asia are rice, maize, millet, and a coarse grain called durra; but in Persia and Syria wheat, rye, barley, beans, etc., are largely grown. The principal trees of Siberia are the pine and birch, of which immense forests exist. The southern regions abound in palms. The tea-plant is a native of China, but it is also cultivated successfully in Assam. Coffee is largely grown in Arabia; and sugar, tobacco, and opium are produced in India and other southern countries. The vine is common in Arabia, Syria, and Persia; and cotton is raised in these countries and in India. Flax and hemp are also common. In the northern regions of Asia the principal animals are the reindeer, elk, dog, wolf, bear, marten, and squirrel; and in the southern the tiger, buffalo, elephant, rhinoceros, monkey, etc. In the central parts are the horse, ass, camel, ox, buffalo, sheep, goat, antelope, lion, tiger, panther, jackal, etc. The birds of Asia are many and various, including the vulture, eagle, buzzard, falcon, parrot, peacock, domestic fowl, etc. Siberia is the great mining region of Asia, yielding gold, silver, platinum, copper, lead, coal, graphite. Gold is also found in Japan, China, India, and in the Eastern Peninsula; silver in China, Mantchuria, Japan, and Asia Minor; tin in the Eastern Peninsula; copper in the Ural and Altai Mountains, Japan, China, and Persia; and coal in China and India. Iron is found in the Ural Mountains and in other parts, and diamonds and other precious stones in India, etc. Most of the inhabitants of Asia are of the Mongolian race, who extend over the whole of northern Asia as far south as the plains bordering the Caspian Sea, including Tibet and China. To this race belong the Chinese, Japanese, Coreans, Tibetans, Tartars, Kirghiz, Mantchus, and Mongolians proper. The Aryan or Indo-European race extend from the Mediterranean across the highlands of Asia Minor, Persia, and Afghanistan to India, and include the Hindūs, Afghans, Kurds, Armenians, etc. The Semitic race occupy the countries south-west of Persia, including Syria and Arabia. Besides these are the Malays, who inhabit the peninsula and most of the islands of the archipelago of that name.

OSTIAKS.

The following are the principal countries of Asia:—

RUSSIA IN ASIA

comprises Siberia, the region of the Caucasus, and the Russian portion of Central Asia. Siberia includes all that immense northern territory of Asia stretching from the Ural Mountains to the Pacific, and from the Arctic Ocean to the northern slopes of the highlands of Central Asia. It is about 4,000 miles in length by 1,900 in breadth, with an area of 4,826,480 square miles, and a population of 3,428,867. The surface is of great uniformity, especially towards the west, where it is an almost unin-

terrupted plain. The northern part is occupied by marshy, frozen *tundras;* the middle portion is largely covered with forests; while the southern region for the most part presents large treeless steppes. The most fertile district is the valley of the Yenisei, where and in other favoured parts good crops of wheat, rye, barley, and oats are raised. Its minerals, however, constitute the chief wealth of Siberia. These include gold, silver, lead, iron, copper, coal, and graphite. The territory of the Caucasus is situated on both sides of the mountain range of that name, partly in Europe and partly in Asia, but is included in Asiatic Russia. It is about 800 miles in length from east to west, by about 500 in width, having an area of 179,500 square miles, and 5,628,300 inhabitants. Its main feature is the central mountain chain which extends almost in a direct line from the Caspian westward to the peninsula which separates the Black Sea from the Sea of Azov. Mount Elburz, the loftiest summit, is 18,526 feet in height. Many of the valleys and plains are of great fertility. Russian Central Asia lies south of Siberia and east of the Caspian, and extends to the Irtish and the Thian-Shan Mountains. It includes the Kirghiz Steppe, Khokand, and portions of Khiva, Bokhara, and Turkestan, having an area of 1,283,500 square miles, and about 4,400,000 inhabitants. The country is mostly steppe and sandy desert, but many of the river valleys are of great fertility.

ARABS.

Turkey in Asia

is bounded north by Russia, the Black Sea, and the Sea of Marmora; west by the Grecian Archipelago, the Mediterranean, Egypt, and the Red Sea; south by the Arabian Sea, central Arabia, and the Persian Gulf; and east by Persia. It comprises Asia Minor, Armenia, Kurdistan, Mesopotamia, Babylonia, Syria (including Palestine), and Arabistan, having an area of 729,000 square miles, and a population of 16,150,000. The surface of Asia Minor is principally an elevated table-land, having in the south the Taurus and in the north the Anti-Taurus mountain ranges. The soil is generally fertile, the climate mild and good, but agriculture is in a very backward state. The mineral wealth is considerable. In Armenia and Kurdistan the surface is a succession of high mountain chains and elevated valleys, and the climate is severe. The western part of Syria is traversed by two parallel mountain chains called the Libanus and Anti-Libanus, while the eastern is an immense desert plain. The most remarkable natural feature in Syria is the great depression of the valley of the Jordan, which sinks to nearly 1,300 feet below the sea-level. Mesopotamia and Babylonia consist partly of a continuation of the great Syrian desert, and partly of alluvial soil, once profusely watered by canals and highly cultivated, but now comparatively neglected. Arabistan, or that part of Arabia which belongs to Turkey, consists of a narrow strip of land stretching along the eastern shore of the Red Sea, and known as the Hejaz and Yemen.

Arabia.

The peninsula of Arabia is bounded west by Egypt and the Red Sea; south by the Arabian Sea; east by the Persian Gulf; and north by the great Syro-Babylonian plain. That portion of Arabia which is independent of Turkey embraces all the interior and the south and east coasts, and is inhabited by Arabs, who are governed in a patriarchal manner by sheikhs. The soil is for the most part barren and sterile, much of it being sandy desert, and the climate hot; but cultivation is carried on in some parts, and considerable crops of wheat, barley, durra, beans, etc., are raised. The area of Arabia is estimated at 1,220,000 square miles, and the population at about 5,000,000.

AGRICULTURE.

It is not hard to understand the charm with which farm-life is invested to the dweller in cities, worn and worried and weary. Even to-day the *beatus ille* of Horace is echoed by many a man who would be *solutus omni fœnore*. The very contrast between the dust and din of town and the health-giving breezes of the country is sufficient to excite a longing for rural enjoyment; and recollections of walks and rides in the clear fresh morning air over

elastic turf are not calculated to deaden the desire. And in good sooth there are some cases in which the pictured delights of farm-life may be almost realized. The wealthy owner of a model farm, who does not grudge the expense of his pastime may become engrossed in the merits of shorthorns, and can always command a cheerful excitement by attending sales (his own or other people's). The toy becomes so real that "making believe" is almost unnecessary. But these are not real farmers, whose livelihood depends upon the success of their labours; and, useful as many of the model farms are to the agriculturist, it would be a grave error to consider "model farms" as models.

Another case in which "farming" in inverted commas is pleasant enough is when it is indulged in by younger sons, who under this name enjoy country sports while a bailiff does the work and prevents the expense becoming ruinous.

But the man who makes farming his business, to whom failure means privation and often ruin, has another tale to tell. To him the disagreeables are near, and cannot be put upon the shoulders of a deputy; while pastoral delights are nonentities, or, like time, unappreciated until lost. When he sees his lambs dying around him,—the lambs that were to have paid the rent; when the harvest upon which his hopes are based fails in its growth or is ruined just as he is on the point of realizing its golden promise—assuredly there is some ground for the grumbling for which our agricultural friends have become proverbial. The records of the bankruptcy courts and the unlet farms of to-day bear only too emphatic witness to the dire plight in which farmers have landed. Into the causes of this it is not our province to inquire; nor is it for us to discuss the remedies that have been suggested; but it is impossible to pass the fact unnoticed.

"Well, such being the case," it may be urged, "it is useless to talk about learning to farm, for nobody will wish to learn." Fortunate for our country it is that this plausible argument is not borne out by facts. Many there are who do intend to become farmers, some it may be by reason of all-controlling circumstances, others shrewdly suspecting that it is not a bad time to begin when the look-out is at its worst. Besides these, who would utilize the wealth contained in the soil of their native land, there are others who seek a wider flight and look to the cattle stations, the sheep runs, or the far-famed corn lands of the Colonies, to yield them a return for their labour and skill and capital. Upon the advisability of this course it would be useless, even if it were possible, to pronounce. The circumstances peculiar to each case are more important guides to a decision than those features which are common to all. It will not be out of place, however, to suggest caution. A mistake will be disastrous, and coming home again is not without expense. Without capital the attempt is vain; and with a small capital, though a young fellow full of pluck and energy may succeed, yet the task will test his powers and his patience. Afar off life seems pleasant, and the glamour shows only the freedom, the excitement, the certainty of success; but behind this there is the stern reality—hard work always, and possibility of failure. We would not discourage the eagerness of the would-be colonist, but common sense itself dictates the maxims:—Don't go without a fair chance of success; don't Micawberize on something turning up: and don't expect to succeed without sticking to work and knowing how to work.

This leads one to the question, How is the needful knowledge to be obtained? The old-fashioned advice was, Learn on a farm, and, at the risk of being stigmatized as antiquated, we are fain to repeat it. But the counsel will be of little use unless it is followed out in the old fashion. The time must be spent in working, not in merely looking on. It looks easy enough to reap or to mow, to shear or to thatch; but it would be as futile to expect to learn these by sight as to become a good skater without putting on skates; and in each case a first attempt will be recognizable enough. This manual skill is not to be despised. It is obviously essential for the man who may become his own labourer: and even to those who remain at home it will not be valueless. There is nothing that makes men respect a master more than to find he is their master in their own line. On the other hand, they feel something very much like contempt, or the agricultural for contempt, towards the man who when necessity arises proves himself a novice after the style of the peasant-squire in the "Monks of Thelema." The moral of which is, Work with your hands; work as if you were a common labourer; and utilize your liberty only to gain a wider experience,—working now in the stables, now with the sheep and now in the market.

Nor is it only manual skill that will thus be gained. Your farmer and your farm-workers are not men of words; they don't talk like a book: and from their lips proceed no glib, well-rounded formulæ. Indeed, unless they are in the humour, you will learn nothing at all of their farm-lore; and they won't be in the humour unless they have a listener whom they have come to know as worthy of their trouble. Yet they have knowledge, and, strange as it may seem, they really do know something of their business. It is true that they are sometimes rated for "errors in practice," and that every sciolist who has skimmed through one or two books on agriculture feels himself a competent critic of farm matters. But sometimes the errors have turned out to be no errors, and the discrepancy between practice and theory has at times arisen from the circumstance that theory relied upon laboratory experiments as an infallible guide to the processes going on in nature's laboratory, where "disturbing influences" are universal and clean test-tubes are unknown. In this laboratory the farmer has been experimenting, with his balance-sheet for scales, and £ *s. d.* for weights; and, blundering as he may have been, it is not to be wondered at that he has wrested from old Dame Nature many a secret which, though valuable, has not yet found its way into print.

There is yet another advantage belonging to this mode of learning—namely, that it in some measure tests the pupil's liking for the work; and liking the work is a good augury.

In selecting a farm upon which to learn, some regard should of course be paid to the kind of farming which the aspirant will be likely to adopt. If his future life is to be in the United Kingdom, it will be desirable to work on a farm either in his district or on one which is similar in character to that in which he hopes to work. If he proposes to go to the Colonies, he will of course pay special attention to those parts of agricultural practice which are most likely to be available in his business. But it would be useless to enter into any further details here, for cases differ so much, and the choice will be practically determined by a judicious use of that valuable faculty known as common-sense. One hint, however, may be given, which is not without its value. After having fairly mastered the elements of the art on one farm, take every opportunity of studying the variations of practice in different districts and even in different farms of one district. Especially would we recommend, from our own personal experience, some sojourn amongst the Scotch farmers. The suggestions given by even a cursory study of comparative agriculture, valuable to all farmers, are especially so to one who has to deal with circumstances new and strange to him.

It now becomes our duty to say somewhat as to the science of farming, and how it is to be acquired. In these days men cannot afford to throw away any help, and in any days he is the most successful (or, as it is said, the most lucky) who avails himself of every help that offers, no matter how trifling it may seem. Indeed, shrewd observers will tell how attention to trifles is just what determines success in farming as in other pursuits. The old proverb, "Take care of the pence," etc., holds good here, and is only limited by that other bit of long-lived learning about "penny-wise and pound-foolish." It is, in fact, a somewhat delicate task to say how far scientific studies should be pursued by the young farmer. In the first place, it is clear that lack of time, if nothing else, precludes the idea of our friend becoming a skilled agricultural chemist, *and* botanist, *and* geologist, *and* naturalist, and a host of *ists* besides. To master one of the branches of learning herein implied is quite enough for most men; the master of all would be an intellectual Hercules, and probably a bad farmer. It can never be too strongly urged that a farmer's main stock of knowledge should be that gained from the farm itself, and that scientific knowledge should be regarded as aiding, but not replacing, this practical wisdom. There is, indeed, a certain peril in too much science, and many a college-taught farmer has come to grief because he trusts to his theoretical knowledge and forgets its necessary imperfectness. He may be advanced in his scientific lore sufficiently for examination purposes, but probably he has still to realize that the application of this lore to practical problems is a matter requiring the detailed knowledge of a specialist, and even then should be verified by field experiments on a small scale. Let it be a rule to stick to the usual practice of the district, to follow the lead of one's predecessors, until a suggested alteration has been proved desirable by farm-trials on a small scale. We poor mortals are but short-sighted beings, and are apt to forget or overlook conditions that upset the schemes which, on paper, seem impregnable.

There is probably little chance of error in this way to one who learns on a farm: for the open air seems antagonistic to books, and farmers as a rule are not over fond of reading. But experience is not wanting which shows that a warning is needed against neglect of practical knowledge practically acquired. When a man knows enough of the elements of science to intelligently follow a not too technical paper in which a specialist expresses his views upon farm-practice,—when he can collect a sample for analysis, and can understand the chief points of the analyst's report, he will probably have as much scientific knowledge as he wants. The addition to this of some acquaintance with the scientific explanations of the more important items of farm routine, known of late as the Principles of Agriculture, will be a great help to any one learning the practice of agriculture, and may safely be recommended.

Amongst the institutions in which agriculture is taught, the first that come to mind are the colleges at Cirencester, in Gloucestershire, and at Downton, near Salisbury. Upon these we do not propose to say much: partly because the fees put them beyond the reach of the sons of most tenant-farmers, and partly because these colleges issue detailed prospectuses which should be consulted by any intending student or his friends. A visit to the colleges during term-time is a desirable and not unenjoyable preliminary, while much may be learnt of the style of work from students who are at the college or have recently left.

In the Normal School of Science at South Kensington, agriculture is to be taught. But, as arranged at present, this is useless to farmers or would-be farmers, unless they can spend four of the best years of their life in purely theoretical studies.

Edinburgh and Aberdeen offer facilities to those who wish to become acquainted with the scientific aspects of farming; and from these centres have come many distinguished agriculturists.

In Ireland there is a whole group of agricultural schools, headed by Glasnevin. At the Royal College of Science in Dublin there is, or was, a chair of agriculture; but as to the existence of a class we are less confident.

There is another teaching agency that some of our readers may be glad to hear of. This is the Colonial section of the Crystal Palace educational scheme. As far as we can judge, this section is well worthy of attention from those who mean to become colonists.

Besides these bodies, whose main function is teaching, there are others in which the fashionable panacea of the day—examinations—is

countenanced. With one exception, which will be noticed by-and-by, these examinations do not appear to be largely attended; and probably most of the examinees are those who have been students in some of the institutions mentioned above. The Highland and Agricultural Society holds annual examinations, and awards certificates; but there are hopes that ere long this famous body will take a yet more active part in spreading agricultural education in North Britain.

The Royal Agricultural Society of England also grants certificates upon the results of examinations held annually at Hanover Square. The same Society performs an even more useful work in that it encourages agricultural education in schools in rural districts.

The success of these efforts has been far surpassed by that which has resulted from the establishment of "Principles of Agriculture" as a subject under the Science and Art Department. The examinations under this scheme are held all over the kingdom, and the examinees are counted by thousands. Moreover there is an equally widespread system of teaching, the fees for which are very low. The quality of the instruction given varies, as is to be expected; but many instances are noted in the local press in which the lecturers appointed under the Department have succeeded in attracting to their classes, and keeping as interested auditors, some of those actually engaged in farming in the neighbourhood. This circumstance is of itself sufficient to prove that the information conveyed is really of use.

We must not pass by in silence the question of agricultural teaching in schools. In some schools this is a part of the ordinary course; and there really does seem no good reason why a farmer's son should not have acquired with his other school learning some of the rudiments of agricultural science. There is no lack of books sufficiently simple for the purpose; and a lad who has been grounded in these matters will have a better chance of picking up information on a farm than one who knows nothing but Latin and the like. At the same time the mysteries of book-keeping, hated by students of an older growth, might be revealed. We are much disposed to welcome any increase of work in this direction.

A farmer's education is only half done when he begins farming. From the farm itself, from the success or failure of his neighbours, from the local Chamber of Agriculture, and from the agricultural press, he can and should be ever learning more.

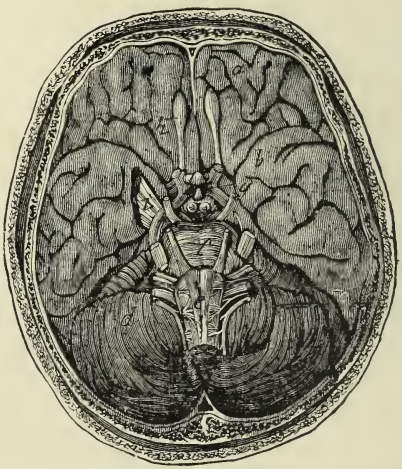


FIG. 5.—THE BASE OF THE BRAIN.

a, the anterior lobe; *b*, the middle lobe; *c*, the occipito-parietal fissure; *d*, the cerebellum; *e*, the medulla oblongata; *f*, the pons Varolii; *g*, optic commissure; *h*, bulb of the olfactory nerve; *i*, crus cerebri.

III.

STRUCTURE OF THE BODY (*continued*).

The Chest.

IF we now take another view in the same way as that mentioned in our last article, across the middle of the chest, we find, as before, muscles beneath the skin. But at the sides there are stout bony rods extending from the spine on either side, and forming a definite boundary to the cavity of the chest. Towards the front these become gristly, and then are connected in the middle line with a thick flat bone, the *breast-bone*. Embedded in the flesh of the back we discover another flat bone, the *shoulder-blade;* but this is not directly connected with the chest.

Cavity of chest.

Enclosed by bones.

The spinal column encloses, as in the previous case, the spinal cord; and in front of it is the immensely larger cavity of the chest or *thorax*, surrounded by the bones and muscles just mentioned. Within it are solid masses or organs which have a different aspect from those of the abdomen. Just in front of the spine several tubes are cut: one of them passes from the mouth to the stomach, and is the gullet. Others are the bronchial tubes, extending from the windpipe to the lungs; and smaller openings are to be seen here and there, which are the mouths of branches from the same tubes. Further, another series of openings are those of bloodvessels, the arteries and veins—the former taking blood *from* the heart, the latter conveying it *to* the same organ.

Air and food tubes.

Bloodvessels.

The greater part of the space in the chest is occupied by a pair of elastic masses, the *lungs*, which contain air all through them, and in which the bronchial tubes branch out. An equally important organ is to be found in front and partially to the left—the *heart*, exhibiting cavities in its interior, which are the blood-chambers.

Lungs and heart.

The Neck.

If we make a cross-cut in the neck, we find a very different arrangement of things, except in regard to the spine. There is no bony circle

in front, and no cavity enclosing solid organs. But we find that many narrow muscles and some broader ones are cut, and that several tubes of considerable size show their mouths: especially the *windpipe*, close under the skin in front, and the *gullet* immediately behind it. At the sides are other smaller tubes—the bloodvessels, which transmit blood to and from the head; and several white nerve-cords, of less dimensions than the vessels, are seen, as they pass downwards from the head and neck to the chest and trunk.

A mass of muscles and tubes.

The Head.

To obtain a view through the head which shall correspond with these we must slice it down from the summit in a line with the front of the ears. Then again we shall perceive two principal cavities; but now the upper one, which is continued from the spinal canal, is very much the larger of the two. This is the brain case, a cavity surrounded by a closely-fitted bony wall, and nearly filled by a large soft organ of a very complex structure—the *brain*. Beneath it we find the cavity of the mouth, with a hard bony roof, the palate, bony sides formed by the lower jaw, and a soft floor of skin and muscle supporting that important muscular organ, the tongue. This is all that represents, in the head, the great cavity of the abdomen, with its intestine and also with what are its numerous organs.

Large brain cavity.

Mouth.

FIG. 6.—VERTICAL SECTION THROUGH THE SKULL DISPLAYING THE RIGHT HALF OF THE BRAIN.

a, the frontal lobe; *b*, the parietal lobe; *c*, the occipital lobe; *d*, the cerebellum; *e*, the medulla oblongata; *f*, the spinal cord; *g*, the pons Varolii; *h*, the corpus callosum or stratum of fibres connecting the two hemispheres of the brain; *i*, the fifth ventricle lying between the layers of the septum lucidum at the anterior part; *k*, the third ventricle placed between the optic thalami and anterior to the corpora quadrigemina: *l*, the tentorium cerebelli, which separates the cerebrum from the cerebellum; *m*, the frontal sinus; *n*, the perpendicular plate of the ethmoid bone; *o*, the nasal cartilage; *p*, the superior maxillary bone; *r*, the Eustachian tube or trumpet forming a communication between the ear and the upper part of the pharynx; *s*, the soft palate; *q*, the pharynx.

But between these two principal cavities we have cut through a smaller pair of bony spaces—the back part of the *nasal cavities*, lying right and left below the front part of the brain-case. There is a middle partition between these two, continued backwards from the division between the nostrils; and the side spaces have thin folded bones covered with soft membrane growing from their walls.

Nasal cavities.

At different spots on the outer surfaces of these bones of the head small muscles are cut across, together with many fine blood-tubes and nerve-cords, packed together most closely and perfectly, and serving in the production of facial expression.

Muscles of face.

The Limbs.

If we now take similar cross sections of the limbs, we find their structure presents an entire contrast to that of the head and trunk. Instead of large cavities enclosed by bone, we have no such arrangement; we find one or more bones constituting the axis of the limb, its firm support, more or less central in position. The bones may themselves contain cavities, but these are not for the purpose of surrounding and protecting other important organs: when they exist it is because they are part of the structure of the bones.

Solid masses with bony axis.

Between these bones and the skin, we find the mass of substance consists of muscle or flesh in different arrangements or bundles. Among these we see the open mouths of larger or smaller tubes conveying blood, and the solid white cords which are the nerves communicating nervous force or impressions from one part to another. All these organs are beautifully packed in relation to one another, so that one cannot conceive a more perfect arrangement of a multitude of small parts within such a limited compass.

Muscles, bloodvessels, and nerves.

THE SKIN.

There is no structure of the body which has more claims upon the attention and study of every intelligent person than the skin. Occupying as it does nearly the entire surface that we can see of ourselves, and being the channel through which we receive every sensation from the outer world, the care of the skin falls within the province of each individual; and to learn about its structure must be necessary in order to a full comprehension of its right treatment.

Channel of sensation.

Two things then are primarily to be remembered in regard to the skin: it is a protecting case for the body, and a sensitive surface. Now, sensitiveness requires delicacy and softness of structure; and with this, of course, goes capability of being easily injured. For protection there must be a certain continuous surface, not too easily penetrated, and ability to sustain some amount of violence without much injury. In the skin these two conditions are met by combining two kinds of structures; an exqui-

Protecting and sensitive.

sitely delicate and sensitive surface is covered by a non-sensitive and neutral coating. External influences can reach the soft tissues through the protecting casing without doing harm to any part.

The Dermis, or True Skin.

The two regions of the skin are called respectively *dermis*, or true skin, and *epidermis*, or cuticle. The dermis is made up essentially of fibrous tissue, the fibres being inextricably matted together, with bloodvessels and nerves permeating it throughout. It is connected by a loose system of fibres with the parts beneath, but this connection varies a good deal in different parts. Over the back, for instance, the skin is very loose and movable; while on the palm of the hand and sole of the foot it is fixed to the parts beneath by stout bands of fibres, with small masses of fat intervening.

Dermis fibrous in structure.

A great feature of the true skin is that, instead of having a flat surface in contact with the cuticle, it is raised and depressed in a peculiar manner. The elevations are often close together, and in rows, and are especially the seats of sensation. They are called *papillæ*, and are usually of a conical shape. In the depressions are found various glands, and the hair bulbs.

Papillæ.

The fibres of which the true skin is composed are for the most part white and translucent, far finer than the finest hairs. With these are mingled yellow elastic fibres, similarly minute, which by their action have much to do with the varying appearance of the skin caused by heat and cold. The interlacement of fibres is very close indeed on that side of the dermis which is near the surface of the skin; but the meshwork becomes much more open deeper down, making room for lumps of fat and the tubes of the sweat glands.

White and yellow fibres.

Muscular fibres of a simple spindle-shaped form are found in the dermis wherever there are hairs; their office being to wrinkle the skin under various conditions, and to erect the hairs. Bloodvessels enter the dermis in small branches, and then break up into very minute capillary tubes, which form a meshwork especially around the fatty masses, the sweat glands, and the hair bulbs. The meshwork is finest and most copious near the surface of the dermis, in and around the papillæ.

Muscular fibres.

Nerves are very abundantly supplied to the skin, but their number varies greatly with the degree of sensibility, for they are for the most part sensitive fibres, which can only convey impressions from the surface to the nervous centres. The individual fibres enter the dermis, and then break up into extremely fine branches, which unite into a meshwork, becoming finer and finer towards the surface of the skin. Many of the nervous fibrils pass to the hair bulbs, many others to the papillæ, ending in special bodies called end-bulbs and tactile corpuscles, where sensation is acute. These will be further dealt with in the physiology of the nervous system.

Nerves and nerve endings.

The dermis is composed chiefly of a substance which yields gelatine by boiling; the bloodvessels and nerves contain albuminous substances. The thickness of the dermis varies in different situations, being from one-fiftieth to one-eighth of an inch. It is usually thicker on the hinder parts than on those in front, and on the outer side of the limbs. It is especially thick on the sole of the foot and palm of the hand. In women the skin is somewhat thinner than in men.

Gelatine.

Variations in thickness.

The Papillæ of the Skin.

These are more or less conical or finger-like projections from the surface of the true skin, serving especially for the development of the sense of touch. Their number and size varies in different parts, according to the sensitiveness of the part; they are large and closely set on the tips of the fingers and toes. The epidermis fills up the spaces between the papillæ to a large extent, but they are really very minute, being from $\frac{1}{100}$th to $\frac{1}{200}$th of an inch in height.

On the tips of the fingers there may be noticed a series of concentric curved ridges and grooves. These indicate that the papillæ of the true skin are here arranged in rows, at intervals, close together. These ridges show the minute openings of the sweat glands.

Ridges on fingers.

Nearly all the papillæ are supplied with very fine bloodvessels, which have a looped shape, the blood entering by one end of the loop and leaving it by the other; or there may be two or three loops in a large papilla. Nerves are supplied to many papillæ, and in them they have special kinds of terminations, adapted to receive sensations.

Bloodvessels and nerves.

XXXVIII.

Practical Application.

(1) Vocabulary XIX.

Les Instruments de Musique et les Musiciens (*Musical Instruments and Performers*).

Les Instruments à Cordes—*Stringed Instruments.*

le violon	*violin*	un violoniste
la viole	*alto*	un violiste
l'alto		un alto
le violoncelle	*violoncello*	un violoncelliste
la contrebasse	*bass*	une basse*
la basse		un bassiste
		un bassier

* Many musicians are called after the instrument they play without alteration of the instrument's name and that name's gender: thus a leader of an orchestra might ask: *Où est la basse?* and the reply might be *Elle est allé se rafraîchir avec la clarinette!*

la harpe	*harp*	un harpiste
la guitare	*guitar*	un guitariste
la lyre	*lyre*	un joueur de l.*
le luth	*lute*	„ „ „ l.†
le piano	*piano*	un pianiste
la vielle	*hurdy-gurdy*	un vielleur.

LES INSTRUMENTS À VENT—*Wind Instruments.*

l'orgue ‡	*organ*	un organiste
la flûte	*flute*	un flûtiste
le flageolet	*flageolet*	un flageolet
le hautbois	*hautboy*	un hautbois
la clarinette	*clarionet*	une clarinette
le basson	*bassoon*	un basson
le fifre	*fife*	un fifre
le cor	*horn, bugle*	corneur, § corniste
le cor de chasse	*French horn*	„ „
le cornet	*small, also rustic, horn*	un cornet un joueur de c.
le cornet à bouquin	*(bovine) horn*	
le cornet à piston	*cornopean* *key-bugle*	un cornet
le trombone	*trombone*	un trombone
l'ophicléide	*ophicleid*	un ophicléide
le serpent ‖	*tenor drum*	un serpent
la trompe	*trumpet, O.S.*	un joueur de t.
la trompette	*trumpet*	un trompette
le clairon	*bugle*	un clairon
la cornemuse	*bagpipe*	cornemuseur
la musette	*Italian ditto*	joueur de m.
le chalumeau	*rustic pipe*	„ „ c.
le mirliton	*reed pipe, a toy*	„ „ m.
l'accordéon	*accordion*	„ d'a.

LES INSTRUMENTS DE PERCUSSION—*Percussion Instruments.*

les timballes, *f.*	*kettle-drums*	un timbalier
le tambour ¶	*drum*	un tambour
le tambourin **	*tenor drum*	un tambourin un tambourineur
le tambour de basque	*tambourine, timbrel*	„ „
la grosse caisse	*big drum*	une grosse caisse
le triangle	*triangle*	un triangle
chapeau chinois	*bells*	un chapeau c.
les castagnettes, *f.*	*castanets*	un joueur de c.
les cymbales, *f.*	*cymbals*	un cymbalier
la cloche	*bell*	sonneur, carillonneur
un orgue de Barbarie	*barrel-organ*	un joueur d'o.
la guimbarde	*Jew's-harp*	„ „ de g.
un harmonica	*harmonicon*	„ „ d'h.

General Remark.—In connection with some instruments special verbs have been applied, some complimentary, others the reverse. Thus one says *toucher de l'orgue, du piano*, and derisively *taper du piano; pincer de la guitare, de la harpe*, and derisively *gratter de la guitare*, to scrape; *sonner de la trompette, donner du cor*, and derisively *corner*. But *toucher, pincer, sonner*, usually yield the place to *jouer*, to play, which is applicable to all instruments: *jouer du piano, de la grosse caisse*, etc. *Battre du tambour*, and *sonner les cloches*, are respectively preferred to *jouer*.

II. FURTHER REMARKS ON SOME VERBS ENDING IN *er* (see p. 468).

a. On verbs ending in *eler*—that is, *e* mute before the final syllable *ler*—as *appeler*, to call. These double the *l* before an *e* mute, else there would occur a sequence of two mute syllables, which would render the pronunciation very harsh. It will be remembered that a double consonant after an *e* mute—here *ll*—has the power of converting the *e* mute into an open one, in the same manner as the grave accent (`) would (§ 23, p. 116, vol. i.). For example, the future in the model being *je parlerai*, the future of *appeler* should be *j'appelerai;* but both *e*'s being mute, the result would be *j'applrai*, which no one would attempt to pronounce. By doubling the *l*—*j'appellerai*—we obtain the sound *j'a-pèl-rai*, which is quite euphonic. This change occurs twenty-one times in the verb, because the stem of a verb in *er* is twenty-one times followed by a mute syllable. That is the rule. Unfortunately, it is as much honoured in the breach as in the observance. The verbs that are excepted from it place a grave accent on the penultimate mute *e*; the result is identical as to sound, but the difficulties of spelling are much increased. We append all but full lists of both classes of verbs.

Verbs which double the *l*:

amonceler, *to heap up*	étinceler, *to sparkle*
appeler, *to call*	ficeler, *to tie up*
atteler, *to harness*	morceler, *to parcel out*
carreler, *to lay with tiles*	museler, *to muzzle*
dételer, *to unharness*	emmuseler, *to muzzle*
ensorceler, *to bewitch*	niveler, *to level*
épeler, *spell*	renouveler, *to renew*

Verbs which place (`) over the penultimate *e*:

bourreler, *to torment*	écarteler, *to quarter*
celer, *to hide*	geler, *to freeze*
congeler, *to congeal*	harceler, *to harass*
déceler, *to reveal*	marteler, *to hammer*
dégeler, *to thaw*	modeler, *to model*
démanteler, *to dismantle*	peler, *to peel*

Remark.—On *botteler*, to bottle; *bretteler*, to scrape stones; *ciseler*, to chisel; the *Académie* offer no opinion; *Littré* suggests option. It would be as well to bring them under the general rule.

b. On verbs in *eter*—that is, *e* mute before the final syllable *ter*—as *jeter*, to throw. These double the *t* for the same motive and in the same places where the above double the *l*. Here also we find verbs taking ` instead of doubling the *t*. The *Académie* even presents the anomaly *j'épousterai*, I shall dust, without either (`) or *tt*. *Littré*'s view, given below, is preferable.

Verbs which double the *t*:

cacheter, *to seal*	projeter, *to project, intend*
décacheter, *to break the seal*	rejeter, *to reject*
recacheter, *to re-seal*	haleter, *to pant*
épousseter (Littré), *to dust*	fureter, *to ferret*
feuilleter, *to run through a book*	soufflеter, *to box the ears*
jeter, *to throw*	tacheter, *to speckle*

Verbs which place (`) over the penultimate *e*:

acheter, *to buy*	décolleter, *to bare one's neck*
becqueter, *to peck*	étiqueter, *to label*
colleter, *to collar*	racheter, *to redeem*
crocheter, *to pick locks*	trompeter, *to trumpet*

Remarks.—1. On *banqueter*, to feast; *breveter*, to grant a patent, the *A.* offer no opinion, because these verbs are hardly ever used out of the infinitive and past participle. *Littré* suggests option. 2. It is particularly in this class of verbs that unlettered Frenchmen and some foreigners trip. As *épousseter*, for example, is pr. *épousster*, no French domestic would ever dream of saying anything else but *j'épousst' les meubles*, whereas *j'époussète* is the correct sound.

c. On all other verbs in *er*, whose final syllable—as *mener*, to lead—is preceded by an *e* mute. These change the *e* mute into *e* grave by means of the accent before a mute syllable. The present indicative of the model being *je*

* The term *un lyrique* may be applied to a lyrical poet.

† *Le luthier*, or *facteur*, is a stringed instrument maker.

‡ Is masc. in the sing. and fem. in the plur. In speaking of an organ of large dimensions, one says as readily *les orgues* as *l'orgue de cette église*.

§ Generally taken in an uncomplimentary sense—a *bruyer*.

‖ An undeveloped sort of ophicleid, often found in churches.

¶ The drummer, in speaking of his instrument, calls it *la caisse*.

** A sort of elongated drum.

parle, the corresponding form in *mener* should be *je mene;* but as both syllables are mute, the result is *m'n'*, which cannot be pronounced at all. Hence the use of `—*je mène*.

d. On verbs in *er*, which, like *répéter*, to repeat, have their final syllable preceded by *é* (a close *e*). These change *é* into *è* before a final mute syllable only, for in the future and conditional they retain *é*. Say, therefore, *je répète*, but *je répétais, je répéterai*. Verbs in *éger*, which used to maintain *é* throughout, now strictly follow the general rule: *j'assiège, j'assiégeais, j'assiégerai*.

Remarks.—1. The necessity of the change of *é* into *è* is not so apparent as that of *e* into *è*, as in *e* above. The only assignable reason is that French affects open sounds before mute syllables. 2. Grammars written in this country sometimes state that verbs in *uer*—as *éternuer*, to sneeze—place a diæresis over the *i* in the first and second persons plural of the imperfect indicative and present subjunctive—*nous éternuïons, vous éternuïez*, etc. That practice is now entirely discarded in France.

XIX.

MAGNETISM (*continued*).

OUR readers will have already seen that although both steel and iron have the power of accepting the magnetic condition, yet they differ from each other in the readiness with which they accept it, and with respect to the length of time during which they retain it.

Coercive force.

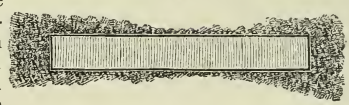


FIG. 63.

In point of fact, it is found that whereas soft iron very speedily, indeed *immediately*, accepts the magnetic condition, it as immediately loses it upon the influencing magnet being withdrawn.

Difference between iron and steel.

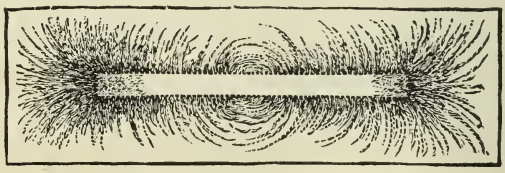


FIG. 64.

Steel, on the other hand, can only be magnetised with some difficulty, but having once accepted the magnetic condition it retains it for a prolonged period. This resistance on the part of steel to magnetism and its retention of it when once acquired is termed, somewhat unhappily, *coercive force*, and this is said to be very great in steel, but almost absent in soft iron.

A very beautiful experiment either with a horseshoe magnet or with one or two bar magnets is the following:—Take a sheet of glass or of writing-paper, and place beneath it first an ordinary horseshoe magnet. Then sprinkle lightly upon the glass or paper a few iron filings, gently tapping the glass every now and then. The filings will arrange themselves round the poles of the magnet in the most beautiful curves, as represented in fig. 63.

These lines are known as the *magnetic curves* or *lines of magnetic force*. Now substitute for the horseshoe a bar magnet, and, proceeding as before, the arrangement of the magnetic curves will be as in fig. 64.

Magnetic curves.

Finally, place two bar magnets parallel to each other with their poles reversed—that is to say, the north pole of one opposite to the south pole of the other.

We have already said that the earth is considered to be a great magnet, having its north and south poles, and have in this way attempted to account for the tendency of a freely-suspended magnetic needle to set itself in a direction nearly corresponding to the geographical north and south. As we have also intimated, the north and south *magnetic* poles are not precisely coincident with the north and south *geographical* poles.

Magnetic poles.

Both the magnetic poles of the earth were discovered through the investigations of Sir James Ross: the north magnetic pole in 96° 43′ west longitude, and 70° north latitude; and the south was calculated to be at that time (1830) in about 154° east longitude, and 75½° south latitude.

An imaginary line joining the two poles of a magnetic needle is termed the *magnetic meridian*, and it is therefore in this direction that a magnetic needle settles to rest. The line joining the north and south geographical poles is termed the *geographical meridian*, and the angle which at any place is made between these two meridians, or, what is the same thing, the angle which the needle makes with the geographical meridian, is termed its *declination* or *variation*. This declination, which is expressed in degrees (°) and minutes (′), is said to be east or west, according to whether the north pole of the needle is east or west of the geographical meridian.

Magnetic meridian.

The declination of the needle varies not only at different places, but also at different times at the same place. Some of these variations take place daily, some annually, some only after long intervals of time. All of them are comparatively regular, and are so denominated; but, in addition, irregular disturbances of the needle take place, which are known as *magnetic storms*.

Variation of declination.

The variations in the declination of the magnetic needle, which are only apparent after long intervals of time, are termed *secular* variations; and the following facts with regard to these changes in London and Paris will sufficiently illustrate their character.

Secular variations.

At London, in 1580, the declination of the needle was 11° 36′ east; in 1663, it was zero—that is, the magnetic and geographical meridians coincided. From 1663 to 1818 the needle gradually turned towards the west, and in the latter year reached its maximum western declination, which was 24° 41′. Since 1818 it has gradually diminished, and is now (1882) about 18° 46′.

At Paris the needle has varied in declination according to the following table :—

Year.	Declination.	Year.	Declination.
1580 . . .	10° 30′ E.	1825 . . .	22° 22′ W.
1663 . . .	0	1830 . . .	22° 12′ W.
1700 . . .	8° 10′ W.	1835 . . .	22° 4′ W.
1780 . . .	19° 55′ W.	1850 . . .	20° 30′ W.
1785 . . .	22° W.	1855 . . .	19° 57′ W.
1805 . . .	22° 5′ W.	1860 . . .	19° 32′ W.
1814 . . .	22° 34′ W.	1865 . . .	18° 44′ W.

At some places on the earth's surface there is no declination of the magnetic needle. These places are connected by a curved line on the map, which is termed a *line of no variation*, or *agonic line*.

Agonic lines.

To those imaginary lines which connect places having the same declination, the term *isagonic* lines is applied, and the maps on which such lines are depicted are termed *declination maps*.

Isagonic lines.

Beside the secular variations in declination, the magnetic needle undergoes minute annual variations.

These were first discovered by Cassini in 1780. At Paris and London this variation is greatest about the spring equinox (March 21st), and diminishes from that time to the summer solstice (June 21st), and then during the following nine months slowly increases. The amount of this variation is from 15′ to 18′.

Annual variations.

The *diurnal* variations in declination were first discovered in 1722 by Graham, and require the employment of very delicate instruments for their detection.

Diurnal variations.

From observations which have been made, it is found that in England the north pole moves from east to west from sunrise until about one or two o'clock. It then begins to return, and at about ten o'clock at night regains its original position, and during the night remains almost stationary.

Another important point to be noticed in connection with the directive tendency of the magnetic needle is the angle which it makes with the horizon.

Inclination or dip.

If a magnet be so suspended that it is free to move in a vertical plane, it will be found that it does not come to rest in a horizontal position, but that (in this country at least) it rests with its north pole pointing downwards. This is termed the *inclination* or *dip* of the needle, and the angle which the dipping needle makes with the horizon is termed the *angle of dip*. This angle of course varies with the position of the needle upon the earth's surface. If the needle were taken to the north magnetic pole it would hang vertically, its north pole pointing downwards. If it were then carried southwards the north pole would gradually rise, until, when the magnetic equator was reached, the needle would be perfectly horizontal, that is, there would be no dip. Continuing to travel southwards, the south pole would gradually be depressed, until, when the south magnetic pole was reached, the needle would again be vertical, but this time with its south pole downwards.

This change in the position of the needle may be experimentally illustrated by passing it along a long bar magnet, when its position would vary, as shown in fig. 65.

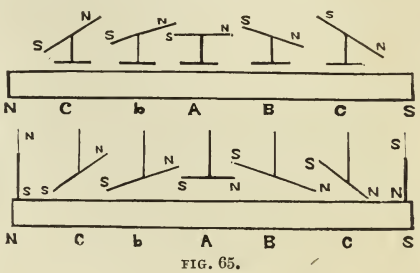


FIG. 65.

At London the angle of dip is at the present time (1882) about 67° 40′.

Like the declination, the inclination of the needle is subject to variations *secular*, *annual*, and *diurnal*.

Variations in dip.

The secular variations may be illustrated by the following particulars respecting the alterations in the dip at London.

In 1821, the dip was 70° 3′; in 1838, 69° 17′; in 1854, it was 68° 31′; and in 1859, 68° 21′.

It will thus be seen that the dip in London is slowly decreasing.

The variations of the dipping needle which occur annually and diurnally are very slight.

The dip is about 15′ greater in summer than in winter, and 4′ or 5′ greater before noon than after.

XLVI.

Syntax of the Verb.

The Subjunctive Mood (continued).

The subjunctive mood is often used to express that something would take place if only some condition too obvious to be mentioned were fulfilled—as in *Credat Judæus, non ego*, the Jew may believe it (if it were told him), but I would not.

The subjunctive mood is sometimes used to express simply a wish, and as such is virtually an *optative* mood—as in *Velim mihi ignoscas*. I could wish that you would pardon me.

The subjunctive mood is often used to express

doubt or *uncertainty*—as, *Incertus sum ubi sis*? I am uncertain where you are.

The subjunctive mood is used with the conjunctions *ut, quò, ne, quin*, and *quominus*, to denote *purpose* and *result*—as, *Pylades Orestem se esse dixit*, UT *pro eo* NECARETUR, Pylades said he was Orestes, in order that he might be put to death in his place. Here *ut* clearly marks the *purpose;* but in *Sæpe fit, ut ii qui debeant, non respondeant ad tempus* (it often happens that those who owe money do not answer to the occasion), *ut* clearly marks the *result.*

The subjunctive is governed by *ne* and *ut* after verbs of *commanding, advising, requesting, exhorting*, and *endeavouring*—*ut* in the *positive* sense, and *ne* in the *negative*—as, *Te obsecro ut me juves*, I entreat thee to help me, and *Te obsecro ne inimicos juves*, I entreat thee not to help my enemies.

Observe especially that where (1) *ne* is used with the subjunctive as *purpose* (*ut* being omitted), it is equivalent to *ut non, quo non*, in such phrases as *in order that, not, lest*—as in *Nolo esse laudator, ne videor adulator*, I do not wish to be a praiser, that I should not appear a flatterer. In all such cases remember to use

ne quis instead of *ut nemo*, that no one,
ne ullus „ „ *ut nullus*, that none,
ne unquam „ „ *ut nunquam*, that never,
ne usquam „ „ *ut nusquam*, that nowhere,

as in *Cave ne quid detrimenti capias*, be on your guard lest you receive anything of damage. But if a *result*, and not a *purpose*, is signified, then remember that the forms *ut non, ut nemo, ut nullus* must always be retained—as in *Hinc fit, ut nullus avarus sit beatus*, hence it happens that no avaricious man is supremely happy. Here *ut* marks the result, and not a *purpose.*

After words signifying fear or anxiety *ne* expresses the apprehension that something *will* happen, *ut* the apprehension that it *will not* happen—as in *Timor civium erat ne hostes rediret*, it was the apprehension of the citizens that the enemy might return; but *Timeo ut sustineas tot labores*, I fear that you will not bear up against so many labours.

Quominus, quin—that not, so that not—is used with the subjunctive mood after negative, or virtually negative, sentences only on the following conditions:—

I. After negative sentences containing verbs of *hindering*—as in *Non prohibeo, quin tu hoc facias*, I do not prevent you from doing this.

II. After such negative phrases as *Non est dubium, quis dubitat, fieri non potest, negari non potest*, there is no doubt, who doubts? it is impossible, it cannot be denied—as in *Quis dubitat quin mundus a Deo creatus esset?* who doubts that the world was created by God?

III. After negative sentences, generally to denote that a certain thing never happens, but that *something else happens*—as in *Nullus ferè dies est quin ad meum domum veniat*, there is scarcely a day but he comes to my house.

Exercises.

Translate into English the following passages from Latin authors:—

Non recusabo quin omnes mea scripta legant. Non erat dubium quin Helvetii plurimum in pugnâ possent. Non possumus quin alii a nobis admodum dissentiant, recusare. Timebam ne evenirent, ea quæ tandem acciderent. Pater terruit gentes ne grave rediret seculum Pyrrhæ. Demosthenes perfecit meditando, ut nemo planius eo locutus putaretur. Gallinæ (*hens*) avesque reliquæ pennis fovent pullos. Atheniensis statuerunt ut, urbe relictâ, libertatem Græciæ classe defenderent. Enitar ut in omnibus rebus tibi prosim. Hoc te rogo atque oro, ne rempublicam deseras. Contendit imperator Cæsar maximis itineribus in fines Nerviorum ut consilia eorum præveniret. Magnopere tibi suadeo ne improbis illis hominibus confidas. Accidit ut milites impransi essent quum signum datum est. Milites cohortatus est ut fortiter castra defenderent. Nonne omnes cives oportet eniti ut reipublicæ prosint? Accidit ut inter Labienum et hostes esset flumen prærltum. Sequitur ut non possim tibi confidere. Enitar ne possis mihi diffidere. Per Trebonium Consulem stetit quominus oppido potirentur. Me infirmitas valetudinis tenuit quominus ad ludos venirem. Hiems prohibuit quominus a te literas haberemus. Bibulum deterruerunt quominus domo exiret. Deterrent me latrones quominus in illam partem urbis eam. Quid tibi obstabat quominus nobiscum adesses? Quis nunc audebit miseros prohibere quominus fleant? Legem brevem esse oportet quo facilius ab imperitis teneatur. Unum vereor ne senatus Pompeium nolit dimittere. Quis est quin cernat quanta vis sit in sensibus?

Translate into Latin:—

I will ask you to do this. Strive to assist me in these matters. Alexander published an edict that no other person than Apelles should paint him. Religion warns all men not to break their word, but to keep it. The consuls published an edict that no one should be allowed to leave the city in time of war except the soldiers. It remains for us to defend our country and to help our friends. It happened that the consuls were about to levy an army. What prevents Caius from being very happy? I think the disease will spread itself throughout all the city, and even throughout all our country. What can prevent you from doing this? Nothing deters a good man from obeying the laws of virtue. I very much dread that you will not be able to endure these so many and so great labours. It was owing to Caius (*per Caium, stetit*) that we did not wage war by sea and land.

Self-Examination Questions.

How is the *purpose* and how is the *result* expressed in the Latin subjunctive? Give instances of each. How is *that*, and *that not* or *lest* translated after verbs of fear? Give examples. What are the three conditions of the use of *quin* and *quominus* in the subjunctive mood?

The Sequence of Tenses in the Subjunctive Mood.

In dependent clauses the tense of the verb in the subjunctive mood must be in concord with the tense of the antecedent or principal verb upon which it depends. As a rule, the present tense subjunctive follows the present and future indicative, and the past tense subjunctive follows the past indicative; but observe that the perfect in a present tense in the indicative with the principal verb is followed by a present perfect in the subjunctive.

The best explanation of the sequence of tenses is that the primary tenses—that is, the present future and present perfect—are subordinated to the primary, and the historical tenses—the imperfect, pluperfect, and simple perfect or aorist—are subordinated to the historical. As for example :—

I. PRIMARY TENSES.

Principal Verb.	*Subjoined Verb.*
queror I complain	*quòd me fraudes* that you cheat me
querar I shall or will complain	*quod me frauderes* that you have cheated me
querar I shall complain	*quòd me fraudaturus sis* that you intend to cheat me
questus ero or *fuero* I shall have complained	
questus sum I have complained	*quòd immemor sis mei* that you are forgetful of me
questus sim or *fuerim* I may have complained	*quòd immemor mei fueris* that you have been forgetful of me
questurus sum (*sim*, etc.) I am about to complain	*quòd mei immemor futurus sis* that you contemplate forgetting me

II. HISTORIC TENSES.

querebar I was complaining	*quòd me fraudares* that you were cheating me
questus sum or *fui* I complained	*quòd me fraudâsses* that you had cheated me
questus eram or *fueram* I had complained	*quòd me fraudaturus esses* or *fores* that you intended to cheat me
quererer I should or might complain	*quòd mei immemor esses* that you were forgetful of me
questus essem or *fuissem* I should, would, might have complained	*quòd mei immemor fuisses* that you had been forgetful of me
questurus eram (*essem*, etc.) I was, etc., about to complain	*quòd mei immemor futurus esses* that you were likely to forget me

Observe, however, that the perfect subjunctive may be used after the past indefinite when the subordinate preposition is conceived of as a distinct historical statement—as in *Æmilius Paulus tantum in ærarium pecuniæ invexit, ut unius imperatoris præda finem attulerit tributorum*, Æmilius Paulus brought such an immense sum of money into the treasury, that the spoils of a single general put an end to the taxes. Observe also that a past tense often follows the historic present in the principal sentence, because the historical present is virtually a past tense—as *Ad eum legatos mittunt, quod dicerent*, they send ambassadors to him, for the purpose of saying. Here mark that *dicerent* is a past tense after the historical present *mittunt*.

XLV.

CHARLES II. (*concluded*).—JAMES II.

THE last period of Charles's reign, from 1680 to 1685, was one of complete reaction. The popular party appeared crushed. The doctrines of passive obedience and non-resistance, and those of the "Abhorrers," who took their name from their professed abhorrence at any interference with the king's power, appeared to triumph completely; and though Charles, in a declaration published in 1681, had expressed his intention of quickly assembling another parliament, he ruled to the end of his reign without one.

Increase of the king's power.

In Scotland, the harsh repressive laws against nonconformity at last produced violence and rebellion. Archbishop Sharpe, hated by the Covenanters as a cruel persecutor, and also as a renegade from their cause, was attacked by a party of fanatics, as he was crossing Magus Muir, dragged from his coach, and murdered before the eyes of his daughter. Horrible as this act was, it had been provoked by the cruel persecution of the Covenanters, who were hunted like wild beasts from one refuge to another by the dragoons quartered in their country, and were daily despoiled, imprisoned, and tortured. A considerable number of them rose in arms, and obtained a success over the royal forces at Drumclog, near Glasgow, where Graham of Claverhouse was obliged to retreat with loss. But the undisciplined Covenanters, who were moreover at variance among themselves, could not follow up the temporary success. The Duke of Monmouth was despatched with troops against them, and on the 22nd of June, 1679, they were entirely defeated at the battle of Bothwell Bridge. It was a crushing blow. Bothwell Bridge long remained a name of humiliation and shame to the Covenanters,—its memory being kept alive by the taunt frequently levelled at them—"Ye're welcome, Whigs, frae Bothwell Briggs." The Duke of Monmouth

Murder of Archbishop Sharpe.

Battle of Bothwell Bridge, 1679.

however, used his victory with lenity, sparing the lives of the captives, and restraining, so far as possible, the licentiousness of the conquering troops: for which he incurred some censure from his own party. The king himself is reported to have said that, if he had been there, government should not have been troubled with prisoners.

Plots, real and pretended, against the king's rule, and the vengeance taken on the men concerned in them, fill up the chronicle of the last days of Charles's rule. A worthy emulator of Oates and Bedloe, the wretched perjurer Dangerfield, came forward with a story of a conspiracy by Presbyterians against the king's life. Failing of success in this direction, he invented a popish conspiracy, to which, from the alleged finding of treasonable papers in a barrel of flour, the name of Meal-tub plot was given. Use was made by the Tory party of these false alarms to insist on the necessity of royal prerogative. Shaftesbury, the boldest among the opposition, was prosecuted for high treason, in 1681; and though the grand jury ignored the bill against

Oates, Bedloe, and Dangerfield.

was going on through Keeling, a conspirator, who turned informer. The chief conspirators were at once arrested, except Monmouth, who fled to the Continent. It suited the purposes of the government to fuse the two plots into one, thus implicating all the prisoners in a charge of attempted regicide; and thus, by the assistance of corrupt and venal judges, a great and crushing vengeance was secured to the court party. Lord William Russell was executed in Lincoln's Inn Fields on the 21st of July, 1683, though his broken-hearted father, the Duke of Bedford, endeavoured to obtain a pardon for him with a bribe of £100,000. Lord Howard had betrayed his fellow-conspirators to save his own head. Lord Essex was found dead, with his throat cut, in the Tower. The trial and execution of Algernon Sidney were rendered infamous by the utterly illegal means used by the prosecution to obtain the conviction of the prisoner, whose private letters, and a treatise written by him long before, were made to supply the want of the second witness required by law in cases of high treason.

Execution of Russell and Sidney.

The triumph of the Duke of York and of the

BOTHWELL BRIDGE.

him, he fled to the Continent, where he died soon after. In 1683 two real plots occupied the attention of the government. The first of these was a scheme to carry out the old design of the Whig party, that of excluding the Duke of York from the succession and securing the throne for Monmouth. Lord William Russell, a son of the Duke of Bedford, Algernon Sidney, the veteran republican, John Hampden, a grandson of the great patriot, the Lords Howard and Essex, and other men of rank, joined in this conspiracy. The other was an ignoble scheme, projecting the assassination of the king and the Duke of York, who were to be shot at from behind a hedge as they returned from the races at Newmarket. This was the Rye House plot, so called from the place of meeting of the conspirators, the Rye House, near Hoddesdon, in Hertfordshire, belonging to one Richard Rumbold, a maltster, formerly a soldier of the commonwealth. The two plots were separate, though each party seems to have had cognisance of the proceedings of the other. The government obtained intelligence of what

Plot of Russell and Sydney.

The Rye House plot.

party of the "Abhorrers" was now complete. Not only did the duke return to England, but he resumed the office of lord high admiral, in defiance of the Test Act. The infamous Titus Oates was no longer in favour: he was accused of libelling the Duke of York, and flung into prison in default of paying an enormous fine to which he was condemned. Everything seemed to point to the permanent ascendency of the doctrines of passive obedience, non-resistance, and divine right, when the reign of Charles II. suddenly terminated. On Monday, the 2nd of February, 1685, the king, on rising from his bed, was suddenly struck down by a fit of apoplexy. He lingered for five days, during which time the Duke of York remained in assiduous attendance upon him. He refused the sacrament at the hands of the prelates of the Church of England, but eagerly took it from Father Huddlestone, a Romish priest introduced by the duke; thus at the last moment avowing himself a Roman Catholic. He bore his sufferings with a firmness and constancy worthy of a better man; and even

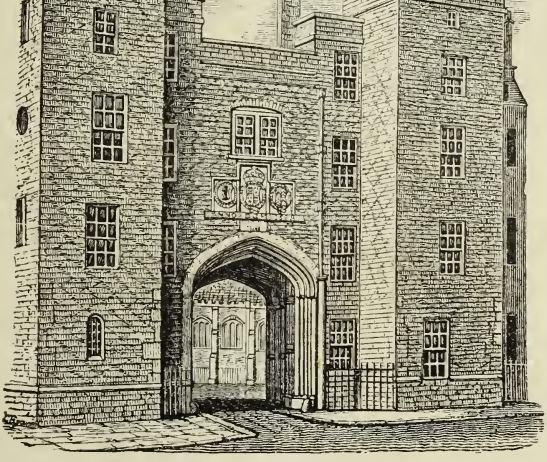
Triumph of the "Abhorrers."

Death of Charles II.

preserved his urbanity to the last—apologizing to his courtiers for being "an unconscionable time dying," and "hoping they would excuse i." When the queen sent to ask his forgiveness if she had offended him in anything: "She ask my pardon!" said the dying man; "alas, poor woman, I ask hers, with all my heart." This, and the injunction he gave, "not to let poor Nelly (Gwynne) starve," are about the best things that can be recorded of the clever, witty, and utterly unprincipled king.

James II., and the Revolution of 1688.

The sudden death of Charles II. took all parties by surprise. Evelyn has described in his diary the brilliant scene at Whitehall on Sunday, the 1st of February: the king among his favourites, the courtiers gambling, with great piles of gold before them; a boy singing love-songs "in that glorious gallery,"—and he tells us how, a few short days afterwards, "all was in the dust."



LINCOLN'S INN GATEWAY.

The Duke of York, now become King James II., declared to the council that he would govern according to the laws. "I shall make it my endeavour," he said, "to preserve this government, both in church and state, as it is now established. . . . I have often heretofore ventured my life in defence of this nation; and I shall go as far as any man in preserving it in all its just rights and liberties." The king also spoke of the Church of England, of its loyalty, and his determination to uphold and support it; and his speech produced a most favourable impression upon the council, and, being printed and circulated, upon the whole nation.

Government of James.

Soon, however, it became apparent that these promises would not be kept. Though the king, for a time, chose Protestant ministers, such as Halifax, Sunderland, and Godolphin, his confidence was given to Catholics like Tyrconnel and Father Petre. His subserviency to Louis XIV. likewise, in which he surpassed his brother, and the favour lavished upon Romanists at court, with the opening of negotiations with the papal government, made men anxious and uneasy. The temper of the time was certainly not prepared to tolerate anything approaching either papal influence or authority.

ENGLISH LANGUAGE AND LITERATURE.

III.

The Norman Period (*continued*).—The Semi-Saxon Transition.

Among the most noted of the trouvères stands Maister Wace, who, in the reign of Henry II., wrote a fabulous history of Britain, called *Le Brut d'Angleterre*, or "the English Brutus," in which he puts forward a son of Æneas the Trojan prince as the first British king. The work was founded on the Latin narrative of Geoffrey of Monmouth. Wace's *Roman de Rou*, or history of Rollo or Rolf, who obtained Normandy from Charles the Simple of France, was the model of many subsequent works of the kind. Wace was liberally rewarded for his works by the English king Henry II. In Ellis's *Specimens*, these works are learnedly treated. The following extract will give an idea of the French poetry of the time. It is part of a description of the festivities at a coronation. The banquet is over, and the lords and knights go forth to amuse themselves with various games:—

Wace the troubadour and his works.

"Li uns alerent behorder,
Et les ineaux chevalx monstrer;
Le autre alerent escrimir,
Ou pierres getier, ou saillir.
Tielx i avoit qui durs lancoent,
Et tielx i avoit qui lutoent;
Chascun del gieu s'entremestoit,
Qui entremetre se savoit.
Cil qui son compaignon vainqueit,
Et qui d'aucun gieu pris avoit,
Estoit sempres mené au roi,
Et à tous les autres monstré;
Et li rois del sien li donost,
Tant donc cil liez s'en alost.
Les dames sor les murs aloent,
Por esgarder ceulx qui joient,
Qui ami avoit en la place,
Tout li tornost l'oil ou la face.

Trois jors dura la feiste ainsi,
Quand vint au quart, au mercredi.
Li roi les bacheliers fienfa,
Enors deliverez devisa,
Lor servise à celx rendi,
Qui por terre l'osent servi;
Bois donna, et chasteleriez,
Et evesquiez, et abbaies."

[Some (the ones) went to joust,
And the fleet horses to show;
The others went to fence,
Or stones to throw, or to jump.
Those there were who darts hurled,
And those there were who wrestled;
Each one in a game mingled,
Who to mingle knew.
He who his companion vanquished,
And who of any game prize had,
Was always led to the king,
And to all the others shown;
And the king of his own to him gave
Until that he went away.
The ladies on the walls went,
To see those who played:
Who a friend had in the place,
All to him turned eye or face.
Three days lasted the feast thus,
When came the fourth, Wednesday.
The king the bachelors enfeoffed,
Also liveries of lands he devised,
Their service to those rewarded,
Who by land had him served;
Woods he gave, and castles,
And bishops' seats, and abbeys.]

A very plain account of the neglect of their native language by the higher classes in England, and an exposure of the disadvantages attending the persistent use of French, is to be found in a passage of the *Polychronicon*, a Latin chronicle written by RALPH HIGDEN, a Benedictine monk of Chester (d. about 1378), in the reign of Edward III. Higden speaks of the gradual change taking place in his time, and very fairly gives both sides of the question. The *Polychronicon* was translated by John de Trevisa, in 1385. The passage in question, translated into modern English, may be rendered thus:—

Higden's Polychronicon.

"This disparaging of the native language is due to two things: first, that children at school, contrary to the usage of all other nations, are compelled to set aside their own language, and to construe their lessons and tasks in French, and have done so since the Normans came first into England. Also gentlemen's children are taught to speak French from the time they are rocked in their cradles, and can speak, and play with a child's brooch. And countrymen will imitate gentlemen, and strive with great pains to learn French, to be more talked about.

"This manner was much used before the first murrain, and has since been somewhat changed. For John Cornwall, a master of grammar, changed the teaching in the grammar school, and (introduced) the construction of French into English; and Richard Pencriche learned that manner of teaching of him, and other men of Pencriche. So that now . . . in all the grammar schools of England children leave French, and construe and learn in English, and have thereby advantage on one side and disadvantage on another. The advantage is, that they learn their grammar in less time than children were wont to do. The disadvantage is, that now grammar-school children know no more French than their left heel; and that is harm for them, if they are to pass the seas and travel in strange lands, and in many other places also. Gentlemen have now greatly discontinued teaching their children French."

Sir John Cornwall introduces English into schools.

In Trevisa's translation the passage stands thus: "This apayninge of the birthe tonge is by cause of tweye thinges; oon is for children in scole, agenes the usage and maner of alle other naciouns, beth compelled for to leve her owne langage, and for to constrewe her lessons and her thingis a Frensche, and have siththe that the Normans come first into England. Also gentil mennes children beth ytaughte for to speke Frensche from the time that thei beth rokked in her cradel and kunneth speke and playe with a childes brooche. And uplondish men wol likne hem self to gentil men, and fondeth with grete bisqnesse for to speke Frensche, for to be the more ytold of."

The Semi-Saxon Transition Period.

But while the Norman and the Latin occupied the high places of the land, the Saxon tongue was still the language of the bulk of the English people. It was not superseded by the foreign tongue introduced by the conquerors: and for two hundred years it continued to hold its own; gradually, however, undergoing a change, whence it is generally known as the Semi-Saxon or Half-Saxon. Hallam, the historian, remarks that none of the principal modern languages was so late in its formation or in its application to the purposes of literature as the English. Nor is the reason difficult to seek. The conquerors looked down with scorn upon the conquered race. "Do you take me for an Englishman?" was in the mouth of a Norman equivalent to "Do you intend to insult me?"—and thus the languages of the two nations ran on for nearly three centuries side by side. Still the change, though very gradual, was continually proceeding. The words were still Saxon, but their forms, and the manner of joining them into sentences, were altering. Hallam says: "In so gradual a transition as probably took place, and one so sparingly marked by any existing evidence, we cannot well assign a definite origin to our present language. The question of identity is almost as perplexing in languages as in individuals. But in the reign of Henry II. a version of Wace's poem of "Brut" (the *Brut d'Angleterre*), by one Sayamoa, a priest of Ernly-on-Severn, exhibits as it were the chrysalis of the English language, in which

The Semi-Saxon from 1066 to 1160.

Gradual change in the language.

he can as little be said to have written as in Anglo-Saxon."

The following specimen will give an idea of the Semi-Saxon language. It is part of a chronicle:—

Bladud hafde ene sune
Bladud had a son

Leir was ihaten;
Leir was (he) called (hight);

Efter his fader daie
After his father's days

He heold this drihlice lond
He held this liege land

Somed an his live,
Together through his life,

Sixti winter.
Sixty winters.

He makade ane riche burh
He made a rich borough

Thurh radfulle his crafte,
Through wise his craft,

And he heo lette nemnen
And he it let name

Efter him scolvan;
After him self;

Kaer-Leir hehte the burh.
Caer-Lear called (he) the burgh.

Leof heo wæs than kinge,
Dear it was to the king,

Tha we, an ure leod-quide,
That we, in our language,

Leir-chestre clepiad
Leir-chester (Leicester) call

Geare a than holde dawon.
Of yore in the old days.

Here we have the same passage in another Semi-Saxon dialect:—

Bladud hadde one sone
Bladud had a son

Leir was ihote;
Leir was hight;

After his fader he held this lond
After his father he held the land

In his owene hond
In his own hand

Ilaste his lif-dages,
Through his life-days,

Sixti winter.
Sixty winters.

He makede on riche borh
He made a rich borough

Thorh wisemenne reade,
Through wise men's counsel,

And hine lette nemni
And he let it name

After him scolve;
After him self;

Kair-Leir hehte the borh.
Kaer-Lear hight the borough.

Leof he was than kinge,
Dear it was to the king,

The we, on ure speche,
That we in our speech,

Leir-chester cleopieth
Leicester call

In than eolde daiye.
In the old days.

The Brut d'Angleterre.

The *Brut d'Angleterre*, of which we have already spoken, is a very curious poem. It is a metrical chronicle of the kings of England, leading down the line from the mythical Brutus, the son of Æneas of Troy. The earlier part was written by a certain EUSTACE or HUISTACE: and the work was continued by ROBERT WACE or GASSE, Canon of Bayeux, and chaplain to Henry II. In the British Museum, among the royal manuscripts, is a copy entitled "Le Brut, ke maistre Wace translata de Latin, en Franceis de tutt les Reis de Brittaigne"; and in some prefatory lines Wace says, "Maistre Wace l'a translate, que en conte le verite."

A great transformation was now going on in the language spoken by the English. The author of the *Amenities of Literature* tells us: "A recent critic opines that LAYAMON seems to have halted between two languages, the written and the spoken. It seems a language thrown into confusion, struggling to adapt itself to a new state of things. It has no Norman-French, it is saturated with Saxon, but the sentences are freed from inversions."

Rhyming Chroniclers.

Rhymed Chronicles.

After Layamon we have a number of writers of rhymed chronicles. We can understand how, at the time when events were transmitted orally, or by word of mouth, more than by the reading of books, the element of rhyme must have been essential, in rendering the words more easily remembered, and that a rhymed chronicle, far more easily committed to memory than one in prose, would accordingly be more popular. Among the rhyming chroniclers one of the chief was ROBERT OF GLOUCESTER, a monk, who wrote his *Chronicle* about 1280. It is a history of England in rhyme, in the Alexandrine lines, though not exactly the Alexandrine satirized by Pope,

> "That like a wounded snake drags its slow length along;"

for Robert of Gloucester's verse, though rugged and uncouth, is not destitute of poetic beauty, and often displays considerable strength.

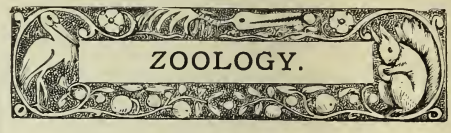
Robert of Gloucester's Chronicle.

Robert of Gloucester's *Chronicle* comes down from the fabulous Brutus to the reign of Edward I. The language represents the western dialect. The following specimen will give an idea of the language and verse of the monk of Gloucester. There was an old tradition or fable, that the great stones of Stonehenge—the old Choir-gaur or "giants' dance"—had been brought by giants from hidden deserts in the

interior of Africa, and deposited in the first instance in Ireland; that each stone had a medical virtue, being washed with medicinal herbs; that they were transported from Erin, at the request of King Arthur, by Merlin the magician, who by his art set them up in circles on Amesbury plain as a sepulchral monument to the memory of the slain Britons. Robert of Gloucester tells the story thus:—

"Sire kyng, quoth Merlin, tho' suche thynges y wis
Ne bethe for to schewe nogt, but wen gret nede ys,
For gef iche seid in bismare, other bute it ned were,
Sone from me he wold wende the gost, that doth me lere.
The kyng, tho non other nas bod hym som quoyntise
Bithinke about thilk cors that so noble were and wyse.
Sire kyng, quoth Merlin tho, gef thou wolt here caste
In the honour of men, a worke that ever schal ylaste
To the hul of Kylar send in to Yrlond,
Aftur the noble stones that ther habbet lenge ystonde;
That was the treche of giandes, for a quoynte work ther ys
Of stones al wyth art ymad, in the world such non ys.
Ne ther nys nothing that me scholde myd strengthe adoune cast.
Stode heo here, as heo doth there ever a wolde last.
The kyng somdele to lyghe, tho he herde this tale,
How mygte, he seyde, suche stones so grete and so faile,
Be ybrogt of so fer dong? And get mist of were,
Me wolde wene, that in this londe no ston to wonke nere,
Syre kyng, quoth Merlyn, ne make noght an ydel such lyghyng.
For yt nys an ydel noght that ich tell this tythyng.
For in the farreste stude of Affric giands while fette
Thike stones for medycyne and in Yrlond hem sette,
While heo woneuden in Yrlond to make here bathes there,
Ther undir for to bathi wen thei syk were.
For heo wuld the stones wasch and ther enne bathe ywis.
For ys no ston ther among thet of gret vertu nys."

This may be rendered in a sufficiently literal manner as follows: "Sire king," quoth Merlin, "though such things I know, they must not be shown but where there is great need. For if I spoke in vanity it would not profit: soon from me would depart the spirit that doth teach me." The king then himself bade him use his cunning, about those Britons' bodies that were so noble and wise. "Sire king," quoth Merlin then, "if thou wouldst build to the honour of (these) men a work that shall last for ever, to the hill of Kildare send to Ireland, for the noble stones that have long stood there; that was the dance of giants, for a quaint work there is, of stones all made with art,—in the world is none such. Nor is there anything that should cast them down with strength. Stood they here as they do there, for ever they would last." The king somewhat laughed when he heard this tale. "How might," he said, "such stones, so great and so many, be brought from such a far land? and it would fail, methinks, for in this land no such stones were." "Sire king," quoth Merlin, "make not such an idle laughing, for it is not idly that I tell these tidings. For from the farthest part of Africa giants once brought these stones for medicine, and set them in Ireland, while they dwelt in Ireland, to make baths there, thereunder for to bathe when they were sick. For they would wash the stones and take their bath, for there is no stone among them that is not of great virtue."



XIX.

The Racoon Family.

We must assign but slight space to the racoons, which inhabit America, and are small members of the bear-like division of the Carnivora, having sharpish knobs upon their grinding teeth, of which there are two fewer than in bears. They are very general in their diet, relishing insects, fruits, or meat. The North American species is hunted with dogs, its fur being valuable. Racoons are curious about everything, and clever in their proceedings and thefts. The Kinkajou of Central America and northern South America is an allied animal distinguished for its long coiling tail, and the usefulness of its paws, which, without "thumbs," serve it as most efficient hands.

Racoons' inquisitiveness.

The Weasel Family.

This is a comprehensive term, including very many animal forms known as gluttons, martens, weasels, badgers, skunks, and otters. Their notability is much increased by the high repute of the fur of many of them, at least half a million skins per annum having been sold for many years. It is marvellous that they should still exist in such numbers, considering the unceasing warfare waged against them; but they include among them the glutton, which is a very serious obstacle to their capture. The family almost universally has fewer teeth than the bears, and this diminution makes the true grinders one above and two below in each side; thus there are thirty-eight permanent teeth. Many of them are remarkably long-bodied in proportion to their height, as well as slender and agile. Their fierceness and pertinacity in attacking prey is generally most intense.

Fur-bearing animals.

Characters.

The Glutton, or Wolverene, the largest member of this family, is very bear-like in appearance, about three feet long, stoutly-built, with short legs and shaggy blackish fur. His claws are sharp and much curved. The teeth are thirty-eight in number, four of the grinders, both above and below, being represented in the first set of teeth, and one above and two below being added in the second set. The skull has high cheek-arches, widely extended, giving strength to the muscles of the jaws.

The glutton.

The glutton extends over British North America and Alaska, and parts of the United States, in the Rocky Mountains especially, to 39°. He also is found in the northern regions of the Old World, from Finland to Kamtschatka,

He has the general appearance of a bear-cub, with the addition of a bushy tail. The very small keen eyes, low ears, large feet, and long hairs emerging from the rest of the coat, give a most peculiar aspect to this aptly-named creature. There is no reason to adopt all the marvellous tales of the glutton's voracity and cunning, to comprehend that it has great capacity for getting food under circumstances of difficulty. Dr. Coues thus sums it up: "It lives in dens or burrows, and does not hibernate. It feeds upon the carcases of large animals, which it finds already slain, but does not destroy such creatures itself, its ordinary prey being of a much humbler character. It is a notorious thief; not only of stores of meat and fish laid up by the natives of the countries it inhabits, the baits for their traps, and the animals so caught, but also of articles of no possible service to itself; and avoids with most admirable cunning the various methods devised for its destruction in retaliation." They will sometimes rob a trapper's lodge of every portable article of furniture. If a dead animal is left by a hunter the glutton will gorge himself if he can get at the meat, and will hide most cleverly all he cannot eat. He has been known to gnaw through a log nearly a foot in diameter, and also to dig a hole several feet deep in frozen ground to gain access to a coveted supply of food. The creature displays great boldness and fearlessness in the presence of man, seizing the carcase of a deer and suffering itself to be shot rather than relinquish its prey.

Appearance.

Habits.

Cunning.

PINE MARTEN.

With the Marten we come to the more typical members of the family, with their long, low, lithe bodies. They spend much time in trees, but are strictly carnivorous, destroying many small mammals and birds. The pine marten is European and Asiatic, still existing in parts of Britain. Pennant's marten is North American. There are two allied species to which the term sable is given, one inhabiting the northern parts of the Old, the other of the New World. Pennant's marten is the largest of this group next to the glutton. It lives much on frogs and mice, but its favourite food is the Canadian porcupine. It will also eat fish, but does not catch it for itself.

Martens.

Sables' skins have long been valued for their full and soft winter fur, the natural colour of which varies from yellowish-white to dark-brown. They are captured by means of simple traps baited with meat of some kind; but the trappers find it most difficult to prevent the glutton from destroying their lines of traps. The sable is a shy and a prolific animal, bringing forth six to eight young at a time, in a den underground, or among rocks, or in the hollow of a tree. Dr. Coues says of it: "Active, industrious, cunning, and predacious withal, it finds ample subsistence in the weaker rodents, insectivora, and birds with their eggs. It hunts on the ground for mice, which constitute a large share of its sustenance. An expert climber, it pursues squirrels, and goes bird's-nesting with success."

Sables.

Habits.

The true Weasel, in addition to a long, remarkably mobile body, has a very long neck, so that it might be suggested that the fore-legs were in the middle of its body. They have one milk grinder less than the gluttons and martens. Professor Bell eulogises the weasel at the expense of its more injurious neighbour, the stoat or ermine, saying that it feeds on field-mice, rats, moles, and is especially a protector to barns, ricks, and granaries, in destroying mice. The weasel, however, climbs trees, catches birds on the nest, and sucks the eggs. A kite has been killed by a weasel, which it had pounced upon and carried into the air. When the kite dropped the weasel ran away unhurt, leaving the kite with a hole through the skin under the wing, and the large bloodvessels of the part eaten through. The female weasel will defend her young against attack even at the cost of her own life.

Ferocity of weasels.

The Ermine, or Stoat, is extremely widely distributed, but is the same animal in Europe, Asia, and America. In size and in ferocity and destructiveness it surpasses the weasel. Its fur is white below, with a little yellow, and brown of various shades above. The softer, finer specimens come from the northern latitudes during winter. The claws are moderately developed, not truly retractile but sharp, and of considerable service in climbing.

The ermine, or stoat.

The word stoat is probably the same as "stout," or bold. The animal derives a technical name from the exceedingly fœtid stench

emitted under the influence of passion by certain glands under the tail. The female is smaller than the male, and brings forth her young in an underground burrow, beneath the stump of a tree, under a pile of rocks, or in the hollow of a tree-trunk.

Stoats have a very keen scent, and are extremely clever in finding the nests of partridges and pheasants; when on scent they carry their noses close to the ground. They are exceedingly agile, and destroy, besides birds, multitudes of rats and moles, young rabbits and hares. Coues says of the stoat: "Swift and sure-footed, he makes open chase and runs down his prey; keen of scent, he tracks them, and makes the fatal spring upon them unawares; lithe and of extraordinary slenderness of body, he follows the smaller through the intricacies of their hidden abodes, and kills them in their homes. The teeth are almost of the highest known raptorial character; the jaws are worked by enormous masses of muscles covering all the side of the skull. The forehead is low, and the nose is sharp; the eyes are small, penetrating, cunning, and glitter with an angry green light. There is something peculiar, moreover, in the way that this fierce face surmounts a body extraordinarily wiry, lithe, and muscular. When the creature is glancing around, with the neck stretched up, and flat triangular head bent forward, swaying from one side to the other, we catch the likeness in a moment,—it is the image of a serpent."

Destructiveness of the stoat.

Serpent-like character.

The Polecat is larger than the stoat, and intensely malodorous—one of its names, "foumart," being probably contracted from "foul marten." The body is about sixteen inches long, the tail five-and-a-half inches. It inhabits Europe generally, more especially the sub-arctic and temperate regions. There is a distinct species, the spotted polecat, in Russia. Polecats are well-known devastators of poultry-yards, and they are fond of fish. When they catch frogs they anticipate the modern physiologist in destroying the brain, to keep them alive in quietness, though not for the useful purposes of scientific study. Stories of the ferocity of the polecat give an idea of its intense pertinacity. Thomas Edward, the celebrated Banffshire naturalist, once had a terrible night encounter with a polecat which he wished to catch. He says: "I actually thought that he would have torn my hands to pieces with his claws. How he screamed and yelled! Although I gripped and squeezed with all my might and main, I could not choke him. . . . I was quite exhausted when the struggle was over. The fight must have lasted nearly two hours. It was the most terrible encounter that I ever had with an animal of his class. My hands were very much bitten and scratched; and they long continued inflamed and sore." A story is told of an encounter between an eagle and a polecat, which resulted in the death of both, the eagle being found with its talons transfixed in the polecat, and the polecat with its teeth fixed in the eagle's gullet.

The polecat.

Struggle with a polecat.

The Ferret is a domesticated variety of polecat, usually a true albino, with white fur and pink eyes. They are bred for rat-killing and hunting rabbits out of their holes. They kill by one bite at the back of the neck.

The ferret.

The Mink, which is found in more than one species, in Europe and North America, is a powerful and fœtid fur-bearer, with strong teeth. It is essentially a water-weasel, spending much time in the water, catching frogs, fishes, molluscs, and crustaceans; but its diet ranges wide, over the same range as the true weasels, excepting that it has little to do with birds. It has a remarkable tenacity of life when caught in a trap, living sometimes many hours under pressure of a heavy log which holds it like a vice, pressing the middle of the body flat. Coues describes the expression of a mink caught in a steel trap, when its captor approaches, as one of the most diabolical in animal physiognomy. "A sullen stare from the crouched, motionless form, gives way to a new look of surprise and fear, accompanied with the most violent contortions of the body, with renewed champing of the iron, till, breathless, with heaving flanks, and open mouth dribbling saliva, the animal settles again, and watches with a look of concentrated hatred, mingled with impotent rage and frightful despair."

The mink.

Expression when caught.

Minks have been tamed and bred in confinement for two purposes—as ratters, and for their fur. They cost little to keep, being fed upon offal. They even become as much domesticated as cats; but they retain their aquatic nature, bathing in a tea-kettle or any open vessel, and then drying themselves in a basket of clean clothes or on a lady's dress. The nest of the female is constructed with grass, leaves, or straw, very firmly compacted with a lining of her own fur. A round opening leads into this, with a sort of door which closes the entrance when she is at home.

Domestic minks.

III.

SOUND (*continued*).

SOUND, like Light and Heat, can be reflected, and obeys the same law, which is usually enunciated as follows: "*the angle of incidence is always equal to the angle of reflection.*" Every reader of this paper has no doubt at some time in his life played with a companion with an india-rubber ball, the two players standing some little distance apart, and not throwing the ball directly from one to the other, but each in turn throwing it on the ground between them, so as to cause it to "bounce" towards the other player.

Reflection of Sound.

This method of playing is represented in fig. 9. Suppose F D to represent a perpendicular rod standing exactly midway between the two boys, and suppose the lad on the right-hand side of the picture to throw the ball to his companion ; the path of the ball will be from C to D and from D to E. The angle C D F (shaded with perpendicular lines), is the *angle of incidence*, while F D E is the *angle of reflection* (shaded with horizontal lines), and, as is seen,

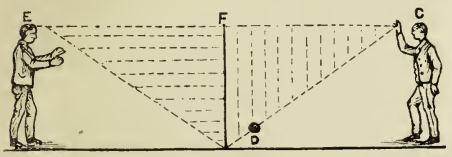


FIG. 9.

these equal one another. In precisely the same manner sound-waves are reflected.

Echoes.

One result of the reflection of sound is the production of echoes, with the nature of which every one is more or less familiar. The existence of echoes is due to the additional fact that the human ear is only capable of distinguishing ten sounds in a second as perfectly distinct and separate from each other—hence the blending of the rapid sounds of machinery into a continual "whirr." If, therefore, a person be a sufficient distance from an object capable of reflecting sound, his voice will produce an echo. By dividing the velocity of sound in air by ten, the minimum distance of the reflecting object from the speaker may be determined. At the ordinary temperature of the air the velocity of sound is about 1125 feet per second, consequently at this temperature the reflected sound must travel at least 112½ feet in order to be heard as a distinct echo ; the person speaking must therefore be at least 56¼ feet from the reflecting body. Should the distance be less than this the reflected sound blends with the original sounds, intensifying and prolonging them.

Remarkable echoes.

Amongst remarkable echoes worth noting are the following :—One at Woodstock Park is said to repeat seventeen syllables by day and twenty by night ; at a villa near Milan is an echo which repeats a shout thirty times ; at the Gap of Dunloe, near Killarney, is also a well-known echo. The production of echoes is very greatly interfered with by intervening objects, such as the furniture of rooms, or the presence of people in a large building. The reflection of sound is illustrated also in the speaking trumpet, ear trumpet, and in whispering galleries.

Refraction of sound.

Sound can also be refracted in the same manner as light and heat. This fact is usually illustrated in the manner shown in fig. 10. B is a collodion balloon filled with carbonic acid gas ; W is a watch suspended behind B, the ticking of which may be distinctly heard by an ear placed at the apex of the cone F. Here the collodion balloon plays precisely the part of a glass lens with light : it *refracts*, that is, "bends" out of their straight path, the waves of sound from the watch, and brings them to a focus at F'. The object of the cone is to collect the waves of sound so as to better direct them into the ear.

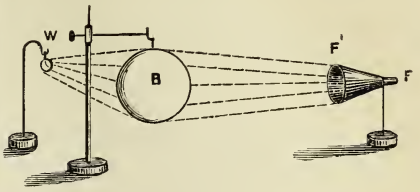


FIG. 10.

Diffraction of sound.

Sound also bends round objects, or is "diffracted." Instances of this may be found in the variations of sound in the noise of a railway train passing through cuttings and along embankments.

The human ear.

One of the most wonderful and perfect acoustical instruments with which we are acquainted is the human ear, a diagram of which is shown in fig. 11. For an exact and detailed description of this wonderful apparatus we must refer our readers to the articles on Anatomy and Physiology appearing in another portion of our pages. For our purpose it will be sufficient to say that the human ear may, for purposes of description, be divided into the external ear, the middle ear or tympanum, and the labyrinth. The external ear comprises the pinna or auricle, and the external auditory canal ; this latter leads up to a delicate membrane termed the membrane of the drum, or "tympanic membrane." The middle ear or tympanum comprises a cavity in the skull containing four openings : one in the front wall closed by the tympanic membrane ; two behind, one round and the other oval, each closed by membrane, and named respectively the *fenestra rotunda* and the *fenestra ovalis ;* the fourth opening leading by a tube, the Eustachian tube, into the back of the mouth. Stretching from the tympanic membrane to the fenestra ovalis is a chain of three small bones, named from their peculiar shape respectively the *malleus* (hammer), the *incus* (anvil), and the *stapes* (stirrup). The internal ear or labyrinth consists of a very complicated series of structures, in which are the fibres of the auditory nerve. The sound-waves reflected into the external auditory canal by the auricle set in vibration the tympanic membrane ; this again sets in motion the little chain of bones with which it is connected ; and they in their turn communicate vibration to the membrane closing the fenestra ovalis. On the other side of the fenestra ovalis is a small quantity of fluid, which is set in motion by the membrane ; and thus motion is eventually communicated to the auditory nerve, by which it is conveyed to the brain.

Noise and music.

Having obtained some notion of the nature of sound in general and the manner in which it is propagated, we have now to consider the nature of the distinction between mere "noise" and those

more pleasing sounds which constitute "music." The reason of the difference in the sensations which these two varieties of sounds produce appears to be that while in noises the vibrations reach our ear in a perfectly irregular and disorderly manner, the vibrations produced by a musical sound succeed each other in perfectly regular and orderly succession. There are, however, some apparent exceptions to this definition; as such a succession of regular impulses as reach the ear when some mischievous boy runs a stick rapidly along an iron railing cannot well be termed musical. Here, however, the impulses do not succeed each other with sufficent rapidity to blend into a musical sound, and the same is the case with the puffs of a steam engine or the ticks of a watch.

In speaking of sounds in general we have already alluded to their intensity, and have shown the conditions upon which it depends; in considering musical sounds we have also to notice the *pitch* of the various notes which can be produced. Every one is familiar with the fact of the existence of "high" and "low" notes, however slight their musical knowledge; and it is also generally known that to these variations in shrillness the term "pitch" is applied by the musician, a shrill note being said to be of high, a grave one of low, pitch: we have now to consider upon what acoustical conditions pitch depends.

Pitch.

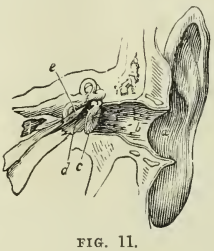


FIG. 11.

THE ORGAN OF HEARING.

a, auricle; *b*, external auditory meatus; *c*, tympanitic membrane; *d*, tympanitic cavity; *e*, eustachian tube; *f*, internal ear.

In order to ascertain the relations which exist between the pitch of a note and the number of vibrations by which it is produced, it is necessary to employ some instrument capable of producing a musical note and at the same time of registering the number of vibrations by which the note is produced. One such instrument, known as Savart's wheel, is shown in fig. 12.

Savart's wheel.

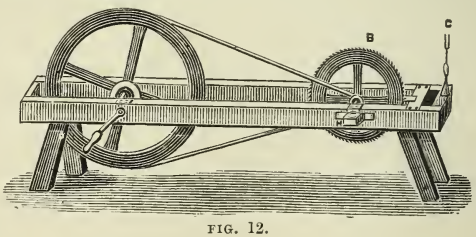


FIG. 12.

As will be seen, it consists of a wooden frame in which a fly-wheel and a cog-wheel connected by a band revolve, the cog-wheel being made to strike upon a card, producing thereby a series of taps which, when the revolutions are sufficiently rapid, are blended into a musical note. To the axis of the toothed wheel, a counter H is attached, which registers the number of revolutions made by B. In using the apparatus to ascertain the number of vibrations per second, say, of a tuning-fork C, the fork is sounded, the apparatus set in motion, and its rate of revolution increased, till the note produced by the taps of the toothed wheel on the card is exactly in unison with that of the fork. The counting apparatus is then thrown into gear, and the revolutions continued for, say, ten seconds. The counter registers the number of revolutions made in the time, and this multiplied by the number of teeth in the wheel and divided by ten (the number of seconds) gives the number of vibrations per second of the sounding body.

Savart's wheel produces musical sounds by a series of taps; but an instrument which is now more generally in use is the "*Syren*," which produces sound by a succession of puffs. The Syren was so named because it can be made to sound under water, but any one hearing its song will feel that it would take a considerable amount of such music to lure them to destruction.

The Syren.

In fig. 13 is a dissected view of the Syren, while another view showing the apparatus for registering the number of vibrations is seen in fig. 14.

It consists of a hollow cylindrical box, C, the top of which is covered by a plate *a b*, perforated by four series of holes arranged in concentric circles; these series contain respectively 8, 10, 12, and 16 holes. Into the bottom of the box passes a tube *t*, which leads from a pair of bellows worked by the feet. Upon the top of the box, a plate, *d e*, having the same number of holes as *a b*, similarly arranged, fits; this plate rotates upon an axle, *p p'*, which works in the frame at the top and also by its lower end in a depression *x*, in the lid of the box. The upper end of *p p'* has upon it a screw, *s*, which works into a pair of toothed wheels, and, as the axis rotates, these wheels are turned by the screw so as to move two index hands attached to them which register upon graduated circles the number of revolutions made by the plate *d e*. The buttons *a* and *b* are so arranged as to throw the wheelwork into or out of gear upon being pressed. The pins *m*, *n*, *o*, *p*, open and close the series of holes in *d e*, so that any series may be used at the pleasure of the experimenter.

The Syren is set in motion by blowing air into the box C from the bellows; and in order that this air may not only produce a musical note but may also serve as the motive power for causing the movable disc to rotate, a very simple but ingenious expedient is adopted. The perforations in both fixed and movable plates do not pass vertically but *obliquely* through them; moreover the directions of the perforations are opposite in the two plates. Consequently the air issuing from the lower plate impinges upon the sides of the perforations of the upper plate, and drives it round.

Action of the Syren.

The instrument being thus set in motion,

the sonorous body the number of the vibrations of which has to be determined is caused to sound, and the syren is rotated until the note produced by it is precisely in unison with the other note; the counting apparatus is then thrown into gear, and the note continued for a certain number of seconds, timed by a watch. At the end of the given time the counting apparatus is thrown out of gear, and, of course, ceases to register, the figures upon the dial indicating the number of revolutions performed by the syren during the time the registering apparatus was in gear; this number, multiplied by the number of holes in use and divided by the number of seconds, will, of course, give the number of vibrations per second which produce the given sound. To make this thoroughly clear, an imaginary experiment may be taken. Suppose the series of holes used to be the one containing 16, and let us suppose further that the disc rotates for a minute, the number of revolutions indicated at the end of the experiment being 1440. As there were 16 holes in the series in use, there must have been 16 puffs or vibrations for each revolution of the disc: multiplying 1440 by 16 we get 23,040 as the total number of vibrations per *minute*, and dividing 23,040 by 60 we get the number 384 as that of the vibrations of the fork per second.

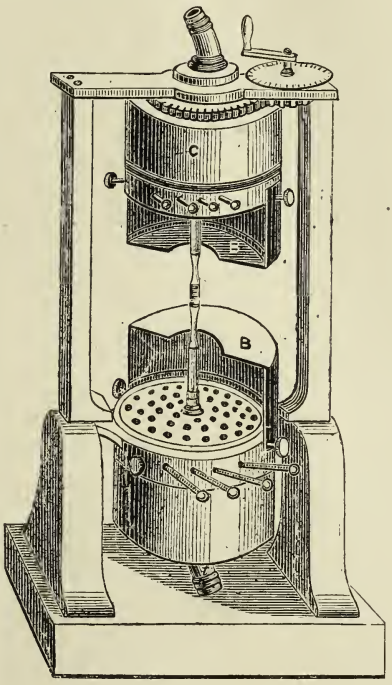


FIG. 13.—THE SYREN.

With the same velocity the syren gives the same sound in air as in any of the other gases or in water; it is therefore evident that any given sound depends on the number of the vibrations and not on the nature of the sounding body.

The syren has been employed to count the number of the vibrations of an insect's wing per second by bringing the instrument into unison with the buzzing or humming noise of these minute organs of flight. The wings of the common gnat have been found to vibrate 15,000 times in a second, and those of many other insects exhibit a rapidity of motion quite as marvellous. Indeed, the revelations of the syren may well fill us with wonder, and lead us to a still firmer belief in that creative power which has framed the universe.

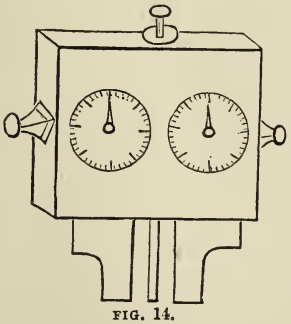


FIG. 14.

MECHANICAL OCCUPATIONS.

I.

THERE are few more important steps in life for a youth or his parents than the selection of the trade or occupation by which he proposes to gain his future livelihood. We purpose in the following paper to endeavour to supply some useful hints bearing on this subject.

Roughly speaking, the occupations engaged in by males may be divided between the professions, the army, navy, and civil service, and police, mercantile life, the counting-house, shop-keeping, farming, trades, and what is generally termed unskilled labour, as that of the agricultural labourer or the navvy (although as a matter of fact *no* labour is really "unskilled"). Some of these subjects have been already dealt with in our pages, and others are out of our purview. We are at present only concerned with what are called "trades."

It is a singular and objectionable characteristic of our time that trades are less in repute than they used to be amongst our more robust and straightforward ancestors. The fact is to be lamented, because it is industry (handicraft) and the productions thereof which form the foundations of states. Whether it be due to the spread of education or to the increase of effeminacy in a prosperous country or not, the fact remains that the children of the working man of to-day nearly always desire to become shopmen or clerks, or something where they can dress smartly, keep their hands clean, wear rings, and be "gentlemen" (save the mark); and their parents (especially foolish working-women mothers) often encourage the pitiful ambition.

This modern abhorrence of and contempt for manual labour should be earnestly combated by every well-wisher of his fellows in pulpit or press on every possible occasion. The nobility and majesty of labour should be upheld, and

the truth of the rude rhyme of our untutored ancestors,

"When Adam delved and Eve span,
Who was then the gentleman?"

pointed out. The prosperity of a country depends upon what its inhabitants produce; not upon what they pass from hand to hand or enter in big account-books. If a man produce *any*thing—a house, a table, a book, a blade of grass, a field of wheat—he benefits the world by so much; but the one who only passes the things made from one hand to the other, as the merchant or shopkeeper, or sets down the fact of such transmission, as the clerk or book-keeper, is, compared with the producer, but a weak cumberer of the earth.

Nor are the rewards of handiwork mean or insufficient. For beside the fact that the artizan has in his trade a livelihood in whatever land he may sojourn, he has also the chance of commencing an independent business which may perchance grow to gigantic dimensions. In this regard his chances are far superior to those of the shopman or the clerk, to whom no such career as that of Stephenson or Brassey is open.

The first consideration, when deciding upon the choice of a trade, must be the lad's physical and mental capabilities and qualifications. Usually the boy does not commence his work until fourteen—an age at which it is comparatively easy to ascertain somewhat of his fitness. His bodily frame will be assuming its permanent form, and, as his school life is concluded, something at least may be gathered of the state of his intellect. As for physical qualifications, it is competent to any parent to judge of these. A small weakly lad should not be apprenticed to blacksmithing, engineering, carpentry or masonry, unless there are some strong reasons for such a choice. A tendency to vertigo or dizziness is a disadvantage for trades using ladders or scaffolding—*e.g.*, bricklayers, masons, carpenters, painters and plumbers. A flat-chested lad, with weak pulmonic conditions, is not adapted for a shoemaker or harness-maker, and still less for a printer or mason, the former trade being especially fatal. A lad with short, stubby fingers, is not well suited for a painter or printer, nor one who squints as a printer or bookbinder. Colour-blindness is an obstacle to many trades.

It is clearly advisable that, so far as possible, the lad's school studies should have some bearing upon the trade which he has chosen for a livelihood. Thus geometrical pursuits are to be preferred to linguistic ones for the youth who selects architecture, masonry, decorative painting or engraving. Some slight knowledge of drawing (especially mechanical drawing) comes in useful for almost every pursuit. Economic chemistry and the history of textiles is of importance to the cotton-spinners and cotton-printers; optics and the theory of harmonious colouring to the painter, printer, and lithographer.

Let us now take a brief glance at some of the means offered to the present generation of acquiring technical teaching quite beyond the reach of their fathers, but very necessary if England is to retain her rank in the industrial scale.

At the present day many advantages are presented to young men in the way of acquiring technical education which have never before existed. Foremost amongst these we may mention the Scholarships in Mechanical Science, founded by Sir Joseph Whitworth, Bart., the great engineer, of which the following are the rules:—

"1. The Whitworth Scholarships are of the value of £200, £150, and £100, and they are open for competition to all Her Majesty's subjects—whether of the United Kingdom, India, or the Colonies.

"2. The candidate must be of sound bodily constitution.

"He must not have completed the twenty-sixth year of his age on the 1st May of the year in which he competes.

"He must have been engaged in handicraft for at least three years, and have been at work at the vice and lathe, or the forge, or the bench, for at least six consecutive months in each of those years.

"He must have spent at least twelve months at the vice and lathe.

"3. Twenty-five Scholarships are competed for in May annually, sixteen of the value of £100, eight of £150, and one of £200, in the following subjects:—

Practical Geometry. I.
Machine Drawing. II.
Building Construction. III.
Naval Architecture. IV.
Mathematics. V.
Theoretical Mechanics. VI.
Applied Mechanics. VII.
Sound, Light and Heat. VIII.
Magnetism and Electricity. IX.
Inorganic Chemistry. X.
Metallurgy. XIX.
Steam. XXII.
Freehand Drawing.

"The competition each year is complete in itself. No *marks* from a previous success in any subject can be counted.

"4. Candidates who are, or intend to be, engaged in machine making—cotton, woollen, flax, etc.; or in engineering—marine, locomotive, and fixed—or in artillery, may only take up subjects I., II., V., VI., VII., VIII., IX., X., XIX., XXII., and freehand drawing. Those engaged in the building trades and coach-making may only take up I., III., V., VI., VII., VIII., IX., X., XXII., and freehand drawing. And those engaged in naval architecture, I., IV., V., VI., VII., VIII., IX., X., XIX., XXII., and freehand drawing.

"5. The number of scholarships awarded in each of the foregoing classes will be proportioned to the number and ability of the candidates from each.

"6. The relative marks in the several subjects and stages, and the method of awarding them, are the same as in the Royal Exhibitions of the Science and Art Department.

"7. No candidate can obtain a Scholarship who has not passed in the second stage, or "Honours," of practical geometry; and in the

second or third stage, or the "Honours" of those stages, of mathematics; and obtained a first class in the first stage, or passed in the second stage, or "Honours," of theoretical mechanics, and obtained a "good" in free-hand drawing.

"8. If a candidate has once *qualified* as above, it will not be necessary for him to be examined again in these subjects, or to pass in them again.

"9. No candidate can obtain a Scholarship who has not attained sufficient handicraft power. And if thought necessary by the Department this may be tested by requiring him to make two Whitworth screw bolts, 1 in. in diameter, and 4 to 6 ins. long, with hexagonal heads and nuts, alike within ·001 in.

"10. Sir Joseph Whitworth will allow the scholars to attend his works at Manchester free of cost.

"11. These scholarships are tenable with the Royal Exhibitions and Scholarships of the Science and Art Department, but not with Admiralty Studentships and Scholarships of the Royal School of Naval Architecture and Marine Engineering; and no person can take a Whitworth Scholarship twice.

The examinations are very complete and searching, and good mathematical knowledge is especially insisted upon. A competent knowledge of mechanical drawing is absolutely indispensable. Further particulars may be obtained from the prospectus of the Scholarships, which can be obtained of the Secretary of the Science and Art Department, South Kensington, price threepence.

The Science Examination Papers given in 1867, price 2*d.*; for 1869 and 1876, price 3*d.* each; 1877, 1878, 1879, 1880, and 1881, price 6*d.*, may be obtained at the book-stall, South Kensington Museum, or on application by letter addressed to the Secretary, Department of Science and Art, South Kensington, London, S.W., enclosing postage stamps or P. O. order payable at the Post Office, South Kensington, London, S.W.

Many residents in London would probably find the "City and Guilds of London Institute for the advancement of Technical Education," Finsbury, useful for them.

Here are evening classes on drawing, organic chemistry (including coal-tar products, brewing, spirit-distilling, vinegar-making, etc.), photographic chemistry, electrical instrument making, etc.; also, day classes on similar subjects. The two lists of subjects in either of which students can be examined in *one* subject are:—(*A*) Alkali manufacture, cotton manufacture, electro-metallurgy, flax, fuel, glass manufacture, mechanical engineering, mine surveying, manufacture of oils, colours, and varnishes, paper manufacture, plumbers' work, zinc and tin-plate work, silk manufacture, sugar manufacture, telegraphy, watch and clock making, wool dyeing. (*B*) Brewing, calico bleaching, dyeing and printing, carriage building, cloth manufacture, gas manufacture, silversmiths' work, lace manufacture, iron and steel manufacture, oils (illuminating and lubricating), mechanical preparation of ores, photography, pottery and porcelain painting, silk dyeing, tanning leather, and tools. The fees are moderate. A limited number of free studentships at University College are awarded to certain classes.

Space does not permit of detailed notice of other British institutions calculated to aid in technical teaching; but we may briefly name the Royal Indian Engineering College at Cooper's Hill; the Crystal Palace School of Practical Engineering, Ditto at Alexandra Palace, Royal School of Mines, Jermyn Street; the Watt Institution and School of Arts (Edinburgh), Glasgow Technical College, the Royal College of Science for Ireland, and the Hartley Institute, Southampton. Further information can in each case be had by writing to the institutions.

After schooling comes the question of actually learning the selected trade, and the need or not of apprenticeship. Of these subjects we shall speak in our next article.

XLV.

The Nebulæ.

The spectroscope has shown these bodies to be immense volumes of gas, sometimes of very complicated structure through partial condensation, but often consisting of simple spherical or ellipsoidal form. They can only be distinguished from the fainter irresolvable clusters by the aid of the spectroscope, which shows the clusters to have the continuous spectrum emitted by incandescent solids or liquids, whilst the nebulæ give a spectrum of bright bands or lines such as is emitted by a mass of glowing gas. Owing to the difficulty and often impracticability of observing the spectrum of the fainter nebulous bodies, it has been found impossible to determine the real character of the vast majority of those known—over ten thousand in number; but there is reason to believe that most are true nebulæ, and not faint star clusters.

Distinction between nebulæ and clusters.

The more interesting of the brighter nebulæ are the following:—

M 1. R. A. = $5^h\ 27^m$. Dec. = —21° 56′. The so-called "Crab Nebula," in Taurus. An oblong, faint mass, which in powerful telescopes is seen to possess an extraordinary complex character, being one mass of streams of condensed nebulous matter.

List of nebulæ.

M 42. R. A. = $5^h\ 29^m$. Dec. = —5° 28′. The great Nebula of Orion. A most magnificent object, and in a good telescope, perhaps, the finest and most gorgeous in the heavens. It covers an area of four or five square degrees, and can be readily detected with the naked eye; yet, strange to say, it was quite overlooked by Galileo, though he paid much attention to Orion.

In the centre of the nebula is the famous trapezium of Orion, the multiple star θ Orionis, consisting of four stars of the 6th, 7th, 7½th, and 8th mag., arranged in the form of an oblique trapezium, whilst two other minute stars of about the 11½th mag. lie without the trapezium but close to the sides and also to the two brighter stars. One or two still fainter stars have been suspected.

This nebula has been carefully drawn by several astronomers, though the different delineations are not quite in harmony with each other. The whole extent of the nebula is filled with stars of different magnitudes ranging from the 7th downwards, but it is quite unknown whether they form part of the same system as the nebula or are merely seen in front of or through it. The spectroscope shows that the nebula itself is a great mass of gas.

1532. R. A. = 7^h 22^m. Dec. = + 21° 9′. Close to δ Andromeda. An example of a very interesting class of bodies, a nebulous star. Consists of an 8½th mag. star, surrounded by a small circular nebula, forming probably a globular envelope to the star. From the drawings it would seem to be a star surrounded by a spherical envelope of glowing gas, some 25″ in diameter.

FIG. 102.—31 M IN ANDROMEDA.

2008. R. A. = 9^h 59^m. Dec. = − 7° 7′. In Sextans. A very distinct nebula, much condensed and brighter towards its centre.

2102. R. A. = 10^h 19^m. Dec. = − 18° 2′. A fine planetary nebula, 2° south of μ Hydræ. A bright elliptical disc of pale blue light, about 40″ in diameter. Larger telescopes show traces of condensed points of light within it.

M. 97. R. A. = 11^h 8^m. Dec. = + 55° 40′. South-east of β Ursæ Majoris. A large faint planetary nebula, 2′ 40″ in diameter. In powerful telescopes it is seen to contain two round darker spots, one containing a faint star, whilst traces of a spiral character are noticeable.

FIG. 103.—CLUSTER 15 M IN PEGASUS.

4234. R. A. = 16^h 38^m. Dec. = + 24° 1′. In Hercules. A very bright small planetary nebula of bluish colour, about 8″ in diameter, and much resembling a star out of focus.

4355. R. A. = 17^h 55^m. Dec. = − 23° 2′. The Trifid Nebula, near μ Sagittarii. A remarkable object resembling a circular nebula condensed towards the centre and divided into three portions by dark rifts meeting in the centre. Full of minute bright stars which render difficult the detection of its gaseous character.

4373. R. A. = 17^h 59^m. Dec. = + 66° 38′. In Draco, half-way between Polaris and γ Draconis. A bright blue elliptical planetary nebula, with a very minute stellar nucleus. The first nebula whose gaseous character was discovered by Huggins.

M 17. R. A. = 18^h 14^m. Dec. = − 16° 15′. The Horse-shoe Nebula, about 5° north of μ Sagittarii. Its most conspicuous portion somewhat resembles a horse-shoe in form, but there are great outlying masses of fainter nebula. Both within and on all sides are numbers of brilliant stars.

M 57. R. A. = 18^h 49^m. Dec. = + 32° 52′. The Ring Nebula, in Lyræ, between β and γ Lyræ. A bright elliptical ring filled with fainter nebulous matter and without any trace of even the faintest star within it. A faint 12th mag. star lies near its eastern edge. One of the most remarkable and interesting nebulæ in the heavens.

M 27. R. A. = 19^h 54^m. Dec. = + 22° 23′. The Dumb-bell Nebula, in Vulpecula, about 4° north of λ Sagitta. An elliptical nebula with a brighter condensed portion in the shape of a dumb-bell lying within. It is surrounded by a number of faint stars, and nine or ten can be seen within the nebula itself, in this respect forming a remarkable contrast to the last.

4628. R. A. = 20^h 58^m. Dec. = − 11° 50′. Near ν Aquaris. An elliptical planetary nebula, about the size of Saturn, and exceptionally bright. Within it there has been detected a bright elliptical ring.

Much interesting speculation has been evolved as to the true nature and constitution of these nebulæ, especially since it has been demonstrated that they are composed, at least mainly, of immense volumes of glowing gas. In a number of cases, these volumes of gases must exceed in dimension the whole known solar system. Some, indeed, must be immense ellipsoidal masses, whose greater diameter must be many hundred times the diameter of the terrestrial orbit. It is not difficult to conceive of the existence of these great volumes of gas; what has seemed so extraordinary is their retaining a sufficiently high temperature to enable them to glow, and to retain the extraordinary forms which some seem to possess.

Nature of nebulæ.

But are these great volumes of gas really incandescent, or even at a high temperature? It does not necessarily follow that they are because they give a bright-line spectrum. There exist good reasons for believing that any large volume of gas, even at ordinary temperatures, would show a bright-line spectrum if only a sufficient thickness were present. These immense masses of gas may be therefore at a comparatively low temperature—lower even than that of our terrestrial atmosphere. But it would not be difficult to imagine them

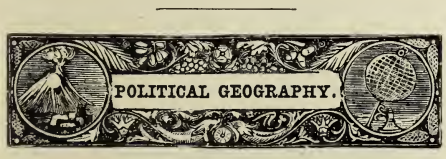
kept at much higher temperature than this by the effect of a slow condensation, due to the presence of some small denser nucleus. If this nucleus were comparatively large, it might give rise to a condensation which would maintain the entire interior of the nebula at a very high temperature and leave only a shallow external envelope at a lower temperature. In any of these ways might be explained the bright-line spectrum given by these nebulæ. The permanency of some of the remarkable forms shown by the nebulæ would be far harder to explain, unless it be supposed that they are grouped round numerous stellar nuclei. And it is remarkable that it is very rarely any of these characters manifest themselves, except in those nebulæ wherein evidence exists of the presence of these nuclei.

Glowing masses of gas.

It may be assumed, therefore, that these nebulæ are great masses of gas, whose temperature is maintained by their slow condensation. As this condensation proceeds it becomes more and more rapid, the temperature of the whole rapidly rises, and after a time an intensely heated incandescent nucleus is formed, and the nebula becomes a star. The nebulæ may be regarded, therefore, as stars *in futuri*, and the condition of a nebula may be regarded as the earliest phase in the history of those numerous masses of matter constituting the stars,—as one of the earliest stages in the history of a solar system.

Constitution of nebulæ.

FIG. 104.—27 M THE DUMBBELL NEBULA.



XII.

PERSIA, OR IRAN,

is bounded north by the Russian Caucasus, the Caspian, and Turkestan; east by Afghanistan and Beloochistan; south by the Persian Gulf and Arabian Sea; and west by Asiatic Turkey. Its greatest length from north-west to south-east is 1150 miles, and its greatest breadth 850, the area being 636,000 square miles, and the population about 5,000,000. The greater part of the country is an elevated table-land bounded on the north, west, and south by ranges of mountains. Those on the north are the Khorasan Mountains towards the east, and the Elburz Mountains towards the west. The mountains of Kurdistan form the western boundary of the table-land, and the mountains of Farsistan and Laristan its southern boundary. The eastern part of the table-land is occupied by the deserts of Khorasan and Kerman, and presents a very desolate appearance; but towards the west, and along the foot of the mountain chains, tracts of great fertility are found. Wheat, barley, maize, and rice are the principal crops raised. Sugar, cotton, tobacco, opium, and wine are also produced. Silk is one of the most important products. The chief manufactures are silk, cotton, and woollen fabrics, shawls, carpets, felts, fire-arms, cutlery, etc. The mineral products are salt, iron, coal, copper, lead, antimony, sulphur, also turquoises and other precious stones. A considerable trade is carried on with India, Russia, Afghanistan, Turkestan, and Great Britain. The government, which is despotic, is in the hands of the shah, and the religion of the country is Mohammedan.

BELOOCHISTAN is a country extending along the coast of the Indian Ocean between Persia and India, and having on the north Afghanistan. Area, 140,000 square miles. It is chiefly mountainous, particularly in the south; and in the north there is a desert similar to that of Persia, called the desert of Beloochistan or Seistan. Along the coast extends the low-lying desert of Mekran. The north-eastern portion of the country is the most productive, and here are grown maize, rice, tobacco, cotton, indigo, the sugar-cane, etc. In other parts are extensive pastures, where large herds of cattle are fed. Gold, silver, lead, iron, copper, tin, and antimony are found here. The inhabitants, who are estimated at about 350,000, are chiefly wandering shepherds; those in the eastern part of the country being under the Khan of Kelat, those in the western under their own chiefs.

AFGHANISTAN

lies between Persia on the west and India on the east, and extends northward from Beloochistan to the river Oxus and Turkestan beyond the Hindoo Koosh mountains. It is about 470 miles in length by 450 in breadth, and has an area of 211,500 square miles. Four-fifths of the surface is covered with mountains and valleys, through which streams flow. The principal of these is the Hindoo Koosh range in the north-east, which rises to the height of over 20,000 feet. The climate varies

in different parts, being very cold on the heights and very hot in the deep valleys. The valleys are generally well-watered and fertile, producing rice, cotton, maize, millet, the sugar-cane, etc. Gold, copper, iron, and antimony are the principal minerals. The manufactures are unimportant, but a considerable transit trade is carried on. Population estimated at about 3,000,000.

Independent Turkestan, or Independent Tartary,

lies between the southern borders of the Russian conquests in Central Asia and the northern limits of Afghanistan and Persia, and extends eastward from the shores of the Caspian to Eastern Turkestan or Chinese Tartary. The surface is for the most part a great plain, except in the south-east, where it is mountainous. It is inhabited chiefly by wandering tribes of Tartars, who form a number of independent khanates or states, the principal of which are the now much diminished khanates of Khiva and Bokhara. The area is estimated at about 194,000 square miles, and the population at 3,000,000.

India, or Hindostan,

is separated from the elevated table-land of Tibet by the Himalaya Mountains on the north; the Sulciman range separates it from Afghanistan on the west; continuous ranges of mountains and wooded hills bound it on the east towards Burmah; while southward the country projects in the form of an irregular triangle into the Indian Ocean for about 1000 miles. Its greatest length from north to south is about 1900 miles, and its greatest breadth 1800, while the area (including British Burmah) is 1,486,320 square miles. In the north the lofty chain of the Himalayas rises from the plain in a succession of ranges till many of its highest peaks exceed 23,000, and some even 28,000, feet, while its loftiest summit attains to 29,002 feet. South of this alpine region is the great plain of Northern India, extending from the Indus to the Brahmapūtra, 1200 or 1400 miles from east to west, and 300 to 400 miles from north to south. The eastern part of this plain, where watered by the Ganges or Brahmapūtra or their tributaries, is very fertile. Westward, however, wild tracts of country occur, overgrown with jungle, the haunts of wild beasts. The Vindhya Mountains extend about 500 miles in an easterly direction from near the head of the Gulf of Cambay to near the Ganges at its middle course, but are of no great elevation. South of these flows the Nerbudda, beyond which are the Satpūra Mountains. The country to the south consists almost entirely of an elevated table-land, bounded on one side by the Western Ghauts, parallel with the west coast, and on the other by the Eastern Ghauts, parallel with the east coast. The northern portion of this country lying between the Nerbudda and Krishna is called the Deccan. In the interior, especially towards the north, the country is wild and overrun with thick jungles, but along the coasts and in the valleys of the rivers tracts of great fertility occur. The principal rivers are the Indus, with its affluents the Suttlej and Ghylum; Brahmaputra; Ganges, and its affluent the Jumna; Godavery; Krishna; Nerbudda, and Mahanuddy. There are numerous canals in connection with the larger rivers, especially in the north, for irrigation. The year is commonly divided into three seasons,—the hot, rainy, and cold. The hot season commences in March, and continues to the beginning of June, when the rainy season sets in and lasts till October. The cold season lasts from November to February. Rice is the staple grain production, but wheat, barley, millet, and maize are also raised. One of the most important products is cotton, besides which are grown flax and hemp, tobacco, indigo, the sugar-cane, opium, tea. The principal minerals are coal, iron, copper, gold, tin, diamonds, and other precious stones. The Hindūs display great skill in several branches of manufacture. The principal imports are cotton goods, metals, silk, liquors, coal; exports, cotton, opium, grain, seeds, skins and hides, indigo, jute, tea, coffee, and wool. Three-fifths of this territory is under British rule, and the remaining two-fifths is under native chiefs, who all acknowledge the sovereignty of Her Imperial Majesty. Her Majesty is represented by a viceroy and governor-general, who is assisted by a council of six members, besides the commander-in-chief. The country is divided into eight provinces. Revenue (in 1880), £68,484,666; expenditure, £69,667,615; public debt, £151,563,802. Army—Europeans, 65,000; native troops, 126,000. Population of British India, 190,653,483; of native states, 52,761,233. The Hindūs constitute 73 per cent. of the population, and Mohammedans 21·45 per cent.

Further India, or the Eastern Peninsula,

is the peninsula lying between the Bay of Bengal and the Chinese Sea, comprising the territories of British Burmah, the Burman Empire, Siam, Anam, French Cochin China, Cambodia, the Malacca States, and the British Straits Settlements. Area about 830,000 square miles; population, 26,000,000. It is traversed by long chains of mountains stretching south from the great table-lands of Central Asia, between which are broad valleys through which flow the Irawaddy, Salwen, Menam, and Mekong. The country lies chiefly within the tropical zone, and the climate is hot and moist, with luxuriant vegetation. The native governments are despotic, and the people are deeply sunk in barbarism.

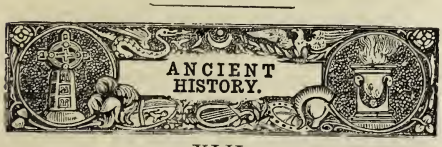
The Chinese Empire

embraces, besides China Proper, with its 1,554,000 square miles, and 405,000,000 of population, Mantchuria, Corea, Mongolia, Tibet, Eastern Turkestan, and Zungaria, with 3,007,800 square miles, and 29,680,000 inhabitants. It has on the north Siberia; west, Turkestan; south, Hindostan and Further India; and east, the Pacific Ocean. Its area is considerably greater than that of Europe, and

more than a fourth of that of Asia. China Proper constitutes about one-third of the whole, and supports a teeming population, whereas the other parts are sparsely populated. It is bounded on the east by the Pacific, and extends inland for more than 1200 miles. There are two great mountain groups in China,—the Pe-ling in the north, and the Nan-ling in the south. Between these is the great plain of China, 200,000 square miles in area, and the most densely populated tract of country in the world. It is irrigated and cultivated in every corner, and highly productive. The principal crop raised is rice, but tea is the most impor- and the sugar-cane are also largely grown. The mineral wealth of the country is very tant article of export produced. Wheat, cotton, great, including gold, silver, lead, iron, tin, coal, precious stones, and porcelain clay. The chief manufactures are china-ware, silk and cotton stuffs, paper, works in wood and ivory, etc. The commerce is mostly internal, the external trade being chiefly with Britain and her colonies. The principal exports are tea and silks ; imports, cotton and woollen goods, metals and opium. In 1880, the imports from the United Kingdom amounted to £5,515,029 ; the exports to £11,826,100. There is also a large trade carried on overland with Russia. The government is an absolute despotism, under an emperor, who is regarded as the vice-gerent of Deity.

JAPAN

consists of three large and numerous small islands, separated from the coast of Mantchuria by the Sea of Japan. The three large islands are Niphon, Shikoka, and Kiusiu. The area of the whole is 147,629 square miles, and population 35,925,313. A chain of mountains of considerable elevation, and evidently of volcanic origin, some of them being still active volcanoes, traverse the group. A great part of the surface is therefore unfit for cultivation ; but other parts are cultivated with great skill, as in China, the principal products being rice, tea, wheat, tobacco, cotton, and the sugar-cane. Gold, silver, copper, iron, and coal are found. The chief manufactures are silk and cotton stuffs, japanned ware, porcelain ware, paper, etc. The emperor (there were formerly two) is an absolute monarch. During the last few years Japan has made wonderful advances in civilization and in the adoption of Western manners and customs.



XLII.

ROME (*continued*).

FOR the next fifty years or so after the events narrated in our last article, the plebeians, aided by their tribunes, had hard fighting to get out of the wretched state of poverty and depression into which they had sunk. The first serious attempt to better their condition was made by Spurius Cassius, who succeeded in carrying an *agrarian law* or land act, the object of which was to divide some of the *public land* among the poor. This public land, or land belonging to the state, was land which had been taken from their conquered neighbours in various wars. Hitherto the patricians had taken the whole of it for themselves, while they ironically called it "public" land. But though Cassius carried the law, it soon became a dead letter, for the plebeians were not yet strong enough to enforce it ; and they were not even strong enough to save Cassius from the revenge of his own order, who accused him of trying to gain popular favour for the purpose of making himself king, on which charge this enlightened statesman was actually put to death, notwithstanding the great services he had done to the state in war.

Agrarian law of Spurius Cassius.

After his death matters grew ever worse and worse, till at last the confusion got so bad that in 451 B.C. both sides agreed that consuls and tribunes alike should give place to ten men elected equally from the patricians and plebeians, and that besides carrying on the whole government these ten men, or Decemviri (*decem* = ten, *viri* = men) as the Romans called them, should write out the laws and publish them, so that every one could know what the laws really ordered. For up to this time the greater part of the laws were known only to the patricians, and therefore it was impossible to know whether their decisions were according to law or not. This task the Decemviri performed with the help of commissioners who had been sent to Athens to study the laws of Greece ; and the laws were then written up in the forum or market-place of Rome, so that all could learn them. You will remember that the Athenians, too, had to get Draco to write out and publish the laws under which they lived.

The Decemviri.

But one of the Decemviri—Appius Claudius by name—a proud and cruel patrician, managed to get nearly all the power into his own hands, and used it very improperly. At last he went too far. He had observed a very beautiful young girl named Virginia, and he formed a plan to get possession of her. He instructed one of his own followers to seize Virginia and claim her as the daughter of his slave. The case was brought to Appius to decide, and of course he decided in favour of the claimant, and ordered her to be given up to him as his slave. But her father Virginius, who was away with the army, hearing of the claim, hurried to Rome, and appeared with his daughter on the day of trial. When the unrighteous judgment was delivered, Virginius craved permission to take his daughter aside to say farewell to her. Then snatching a knife from a butcher's stall, he plunged it into her heart, crying, "There is no other way to keep thee free!" This tragedy so brought home to people's minds the tyranny of Appius, that they determined to do as their fathers had done and leave the city to the patricians. The latter had to give in. The Decemviri were forced to resign. Two of

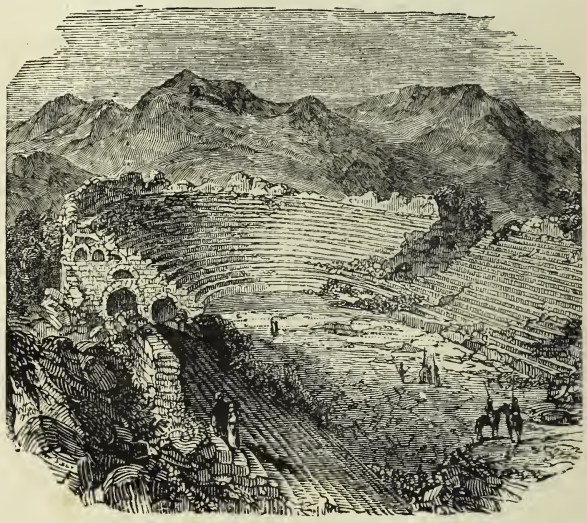
The story of Virginia.

them who had taken the side of the people were elected consuls; Virginius, and Icilius, who had been betrothed to the martyred Virginia, were elected tribunes; and Appius put an end to himself, to escape the doom which too certainly awaited him.

End of the Decemviri.

For the next 150 years the struggle still went on between patricians and plebeians, the latter gaining, step by step, equal power with the former. Our limited space will not allow us to follow the contest through all its exciting incidents. We must content ourselves with observing that by the year 300 B.C. the plebeians had gained perfect equality in political rights, and could hold all the chief offices in the state. First they won the right to make laws in their own assemblies which should have equal validity with those made by the patrician assemblies. Then they got the right to have one of the consuls a plebeian; and when these two rights were granted they soon got rid of all minor grievances. And all through this contest, hard and bitter as it was, there was hardly any rioting or bloodshed, and nothing that could be called a civil war. They seldom went beyond constitutional agitation and passive resistance, keeping their temper and fighting within the law. The sympathies of every free people must be on the side of the plebeians; but our knowledge of human nature compels us to admire also the patricians of Rome, who could sufficiently command themselves to carry on this losing game with so much good temper and moderation, and who knew how to give in with a good grace when they could no longer resist.

Struggles of the plebeians, B.C. 450–300.



REMAINS OF A ROMAN AMPHITHEATRE.

We have followed the internal political development of Rome down to the year B.C. 300, when, as we have seen, the struggle between patricians and plebeians may be considered at an end, the latter having won all that they contended for. But during this time important changes had also occurred in the position of Rome as a power in Italy. She had, notwithstanding her domestic troubles, considerably enlarged her borders, and increased her influence over her neighbours. Of these the Volscians and Æquians were two of the nearest; and naturally, as Rome expanded, she came into collision with them. About the year 468 B.C. she was at war with the Volscians, and the Roman general, Coriolanus—so named in honour of the splendid bravery which he had shown at the taking of Corioli, a Volscian city—stood for the consulship, but was rejected by the people, who were incensed by his haughty arrogance. Next year there was a famine, and Coriolanus advised the senate to give the people no corn unless they would give up their tribunes. For this advice he was banished from Rome by the people. He left in high wrath, threatening vengeance, and betook himself to the enemy's camp. They put him at the head of a great army, with which he marched at once against Rome, overcoming all resistance. The Romans, in despair, sent a deputation of the chief senators to beg that the city might be spared. He refused to hear them. Then a procession of priests came out to intercede, bearing all their most sacred emblems, but they were equally unsuccessful. The city seemed doomed to fall before one of her own sons. At last there came forth from Rome a procession of matrons, headed by his mother and his wife, all dressed in deep mourning. His mother reproached him with that severe dignity which was so marked a characteristic of the Roman matrons. His wife entreated. His wrathful purpose slowly gave way, and at last, in an agony of conflicting emotions, he exclaimed, "Mother, you have saved Rome, but lost your son!" Then he led the Volscians back, leaving Rome unharmed, and soon after died an exile.

Extension of Roman power in Italy.

Story of Coriolanus.

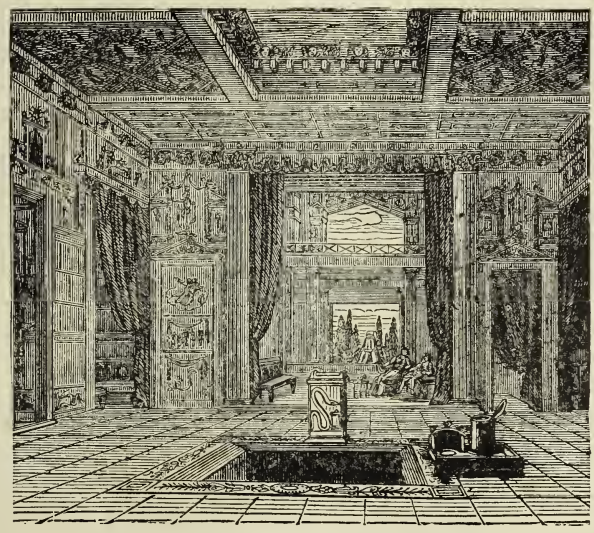
Some ten years later the Roman army had been caught in a defile by the Æquians, and was in danger of annihilation. The senate, on hearing of their peril, at once appointed Cincinnatus dictator. He was absent at his farm outside the city; and when the messengers came to inform him of his appointment he was actually ploughing in the field without his cloak. Calling to his wife to bring him his cloak, he went at once to Rome, and ordered all who could bear arms to be ready at nightfall, and to provide themselves with a supply of food, and with twelve long wooden stakes each. Marching quietly, he surrounded the

Story of Cincinnatus.

Æquians before they knew of his coming. Then the Romans shouted to let their countrymen know they were at hand and encourage them to attack their besiegers; while at the same time Cincinnatus' men threw up entrenchments with the aid of their stakes, and thus the Æquians were caught between the two Roman armies. They had to surrender in a body to the dictator, who marched back in triumph to Rome, laid down his office at once, and returned contentedly to his cottage and his farm.

The first of these stories illustrates the respect shown to women, and the other shows how simply and unostentatiously the nobles lived in those early days of the republic. We shall see hereafter what a contrast there was between this rustic simplicity of the early Romans and the shameful luxury of later times.

As soon as the Æquians and Volscians were beaten, the Romans, under a great and wise general named Camillus, attacked the Etruscans, whose country lay north of Rome, along the western coast of Italy. The Etruscans were a highly civilized people, and gave the Romans considerable trouble. But they were attacked from the north by a new and more terrible enemy than even the Romans. These were the Gauls from France, who for a long time had been pouring over the Alps down on the rich and weakly defended plains of Northern Italy, and gradually pushing the Etruscans south.



ROOM IN A ROMAN HOUSE AT POMPEII, RESTORED.

The Gauls had been very aggressive lately; and when the Romans saw how rapidly they were advancing south, they began to think that Rome itself might soon be in danger if the invaders continued their conquests. So they tried to make peaceful arrangements with the Gauls, but unsuccessfully; and the Roman envoys having imprudently helped the Etruscans in battle against the Gauls, the latter in high indignation marched straight on Rome under their chief Brennus.

The Gauls.

The Romans met them eleven miles from Rome, on the banks of the little river Allia, and were utterly routed, nearly their whole army being destroyed. So complete and crushing was the defeat of the Romans, that all hope of defending the city was abandoned, and most of the people and priests fled from thence. But a brave garrison held the Capitol; and the old senators, who were too proud and patriotic to fly, calmly awaited the barbarians, seated on their chairs of office. The Gauls poured into the city, slew the white-bearded senators, and burned and pillaged the town. But the garrison of the Capitol held out, and contrived to send a messenger to Camillus, who had been shortly before banished for some trifling offence, but whom they now wished to make dictator. Camillus readily forgave his countrymen, and in the hour of peril came to their aid as dictator, with the best army he could gather together. Meantime the Capitol was almost lost.

Rome destroyed by the Gauls.

The messenger who had been sent to Camillus from the beleaguered garrison left traces of his descent, which the Gauls observed. This led them to attempt a night surprise. A party of Gauls silently clambered up, and had just gained the top of the rock when some geese, who were kept as sacred birds on the Capitol, roused a Roman named Manlius, who, rushing to the spot, was just in time to knock the foremost Gaul back over the edge; and by his fall the other Gauls behind were also knocked down the rock, and the Capitol was saved. But starvation soon compelled the Roman garrison to surrender. Brennus demanded a thousand pounds of gold as their ransom; and when it was being weighed out, threw his sword into the scale, to increase the weight against the gold, saying "*Væ victis*," (Woe to the conquered). But at this moment arrived Camillus with his army, and not only reclaimed the gold, but drove the Gauls out, and killed them all (B.C. 390). Such is the story. Its details are probably not quite accurate, but it is certain that the Gauls did about this time destroy Rome. It was rebuilt very hastily and irregularly. Most of the written records of Rome's early history were destroyed, so that we have very scanty materials for the history of the time before this destruction of Rome; but henceforth we have unbroken records. During the next forty years the Gauls renewed their attacks on Roman territory nearly every year; but they never got as far

The sacred geese.

Gauls driven out by Camillus.

as Rome; and the Romans became better able to cope with them year by year, till at last the Gauls were afraid to attack them any more.

XLVII.

Auxiliary Verbs (*continued*).

Mögen may generally be translated *to like*, and in this sense it is generally used—Geh hin, ich mag dich nicht, Go away, I like thee not; Er mochte lieber zu Hause bleiben als ausgehen, He liked better to stay at home than to go out. But in a general way mögen can also be translated by the English *may*—Er mag sagen was er will, ich glaube ihm nicht, He may say what he will, I believe him not. It sometimes expresses a wish or aspiration—Möge der Tag uns etwas gutes bringen, May the day bring us something good.

INDICATIVE.	SUBJUNCTIVE.
Present.	*Present.*
Ich mag, I like (or may)	Ich möge
Du magst, thou likest, etc.	Du mögest
Er mag, he likes	Er möge
Wir mögen, we like	Wir mögen
Ihr möget (or mögt), you like	Ihr möget
Sie mögen, they like	Sie mögen

Imperfect (*Indic. and Subj.*)

Ich mochte, I liked (might).
Du mochtest, thou likedst, etc.

Ich möchte, I liked (might).
Du möchtest, thou likedst, etc.

Perfect (*Indic. and Subj.*)

Ich habe gemocht, I have liked.
Du hast gemocht, thou hast liked, etc.

Ich habe gemocht, I (may) have liked.
Du habest gemocht, thou mayst have liked, etc.

Pluperfect (*Indic. and Subj.*)

Ich hatte gemocht, I had liked.
Du hattest gemocht, thou hadst liked, etc.

Ich hätte gemocht, (that) I had liked.
Du hättest gemocht, that thou hadst liked, etc.

First Future (*Indic. and Subj.*)

Ich werde mögen, I shall like.
Du werdest mögen, thou wilt like, etc.

Ich werde mögen, I shall like.
Du werdest mögen, thou wilt like, etc.

Second Future (*Indic. and Subj.*)

Ich werde gemocht haben, I shall have liked.
Du wirst gemocht haben, thou wilt have [liked, etc.
Ich werde gemocht haben.
Du werdest gemocht haben.

First Conditional.

Ich würde mögen, I should like.
Du würdest mögen, thou wouldst like, etc.

Second Conditional.

Ich würde gemocht haben, I should have liked.
Du würdest gemocht haben, thou wouldst have [liked, etc.

Examples: Ich mochte nicht dieses lange Buch lesen, I did not like to read this long book; Er mag so lang suchen wie er will, er wird es nicht finden, He may seek as long as he will, he will not find it; Ich hätte solches Tuch kaufen mögen, wenn es nicht zu theuer wäre, I should have liked to buy such cloth, if it were not too dear; Es war mir unmöglich meinen Freund zu besuchen, aber ich würde es gemocht haben, It was impossible for me to visit my friend, but I should have liked it.

Wollen expresses a will, a fixed determination, or sometimes an aspiration or wish, as—Dieser gute Fürst will seine Unterthanen glücklich wissen, This good prince wishes his subjects to be happy. It differs from werden in that the latter verb generally designates an occurrence or a consequence: Sie werden zu spät ankommen, wenn Sie sich nicht eilen, You will arrive too late, if you do not hurry yourself; Das Thor wird um sechs Uhr geöffnet werden, The gate will be opened at six o'clock. Sometimes, however, it expresses an intention —Ich werde meinem Freunde ein Geschenk machen, I shall make my friend a present; but in this sense wollen expresses a much stronger intention than werden.

INDICATIVE.	SUBJUNCTIVE.
Present.	*Present.*
Ich will, I will	Ich wolle, (that) I will
Du willst, thou wilt	Du wollest, thou wilt
Er will, he will	Er wolle, he will
Wir wollen, we will	Wir wollen, we will
Ihr wollet (wollt), you [will	Ihr wollet, you will
Sie wollen, they will	Sie wollen, they will

Imperfect (*Indic. and Subj.*)

Ich wollte, I willed, wished, was willing.
Du wolltest, thou willedst, etc.

Ich wollte, I was willing.
Du wolltest, thou wert willing, etc.

Perfect (*Indic. and Subj.*)

Ich habe gewollt, I have willed.
Du hast gewollt, thou hast willed, etc.

Ich habe gewollt, I have willed.
Du habest gewollt, thou hast willed, etc.

Pluperfect (*Indic. and Subj.*)

Ich hatte gewollt, I had willed.
Du hattest gewollt, thou hadst willed, etc.

Ich hätte gewollt, I had (might have) willed.
Du hättest gewollt, thou hadst willed, etc.

First Future (*Indic. and Subj.*)

Ich werde wollen, I shall will, or be willing.
Du wirst wollen, thou wilt, etc.

Ich werde wollen, I shall will, be willing.
Du werdest wollen, thou wilt be willing, etc.

Second Future (*Indic. and Subj.*)

Ich werde gewollt haben, I shall have willed. [etc.
Du wirst gewollt haben, thou wilt have willed,

Ich werde gewollt haben, I shall have willed.
Du werdest gewollt haben, thou wilt have [willed, etc.

First Conditional.

Ich würde wollen, I should will, be willing. [etc.
Du würdest wollen, thou wouldst be willing,

Second Conditional.

Ich würde gewollt haben, I should have been [willing, etc.

IMPERATIVE.

Wolle, be thou willing.
Wolle er, let him (may he) be willing, etc.

Examples: Ich wollte ich hätte die Kraft dieſen armen Leuten zu helfen, I would I had the power to help these poor people; Er wird es thun wollen, He will be willing (ready) to do it; Wolle Gott, daß dieſer theure Freund geneſe, May God will (grant) that this dear friend may recover; Er hat gewollt, daß alle ſeine Diener zu Hauſe bleiben, He has willed (commanded) that all his servants should stay at home.

Sollen expresses the English *shall*, in the light of a command laid upon any one, or of a moral duty or obligation; in which latter case it corresponds to the English *ought*—Sie ſollen nicht ausgehen bis Sie dieſen Brief geſchrieben haben, You shall not go out till you have written this letter; Du ſollſt nicht ſtehlen, Thou shalt not steal. Sometimes it expresses a rumour or a general opinion—Der König ſoll abgedankt haben, The king is said to have abdicated.

INDICATIVE.	SUBJUNCTIVE.
Present.	*Present.*
Ich ſoll, I shall (ought)	Ich ſolle, shall (ought)
Du ſollſt, thou shalt, etc.	Du ſolleſt, thou shalt
Er ſoll, he shall	Er ſolle, he shall
Wir ſollen, we shall	Wir ſollen, we shall
Ihr ſollet (ſollt), you shall	Ihr ſollet, you shall
Sie ſollen, they shall	Sie ſollen, they shall

Imperfect (Indic. and Subj.)

Ich ſollte, I should (ought).
Du ſollteſt, thou shouldst, etc.

Ich ſollte, I should (ought).
Du ſollteſt, thou shouldst.

Perfect (Indic. and Subj.)

Ich habe geſollt, I should (ought).
Du haſt geſollt, thou shouldst (oughtst), etc.

Ich habe geſollt, I should (ought).
Du habeſt geſollt, thou shouldst (oughtst), etc.

Pluperfect (Indic. and Subj.)

Ich hatte geſollt, I ought to have (literally I [had ought.
Du hatteſt geſollt, thou oughtst to have, etc.

Ich hätte geſollt, I should (ought to) have.
Du hätteſt geſollt, thou shouldst have, etc.

First Future (Indic. and Subj.)

Ich werde ſollen, I shall be obliged (morally).
Du wirſt ſollen, thou wilt be obliged, etc.

Ich werde ſollen, I shall be obliged.
Du werdeſt ſollen, thou wilt be obliged, etc.

Second Future (Indic. and Subj.)

Ich werde geſollt haben, I shall have been [obliged.
Du wirſt geſollt haben, thou wilt have been

Ich werde geſollt haben.
Du werdeſt geſollt haben.

First Conditional.

Ich würde ſollen, I should be obliged.
Du würdeſt ſollen, thou wouldst be obliged, etc.

Second Conditional.

Ich würde geſollt haben, I should have been [obliged.
Du würdeſt geſollt haben, thou wouldst have [been obliged, etc.

Examples: Er hätte dieſen Mann nicht verlaſſen ſollen, He ought not to have forsaken this man; Nur wenn wir thun was wir ſollen, können wir mit uns ſelbſt zufrieden ſeyn, Only when we do what we ought we can be satisfied with ourselves; Wann Sie ihre Aufgabe vollendet haben, ſollen Sie ausgehen, When you have finished your task, you shall go out; Der Kaiſer ſoll nach Paris gegangen ſeyn, The emperor is said to have gone to Paris; Die Erfahrung lehrt uns oft was wir thun ſollen, Experience often teaches us what we ought to do; Sollte er morgen kommen, führen ſie ihn zu mir, Should he come to-morrow, bring him to me; Er thut was er nicht ſollte, He does what he ought not.

Laſſen has the meaning to let, to allow—Ich ließ ihn reiten, I let him ride. It also has the meaning to cause. Take the French *faire*—*Il fit pendre le prisonnier*—Er ließ den Gefangenen hangen, He *had* the prisoner hanged.

INDICATIVE.	SUBJUNCTIVE.
Present.	*Present.*
Ich laſſe, I let (cause),	Ich laſſe, (that) I let,
Du laſſeſt (läßt), [etc.	Du laſſeſt, [etc.
Er laſſet (läßt),	Er laſſe,
Wir laſſen,	Wir laſſen,
Ihr laſſet (laßt),	Ihr laſſet,
Sie laſſen,	Sie laſſen,

Imperfect (Indic. and Subj.)

Ich ließ, I let.
Du ließeſt, thou lettedst.
Er ließ, he let, etc.

Ich ließe, (that) I let.
Du ließeſt, thou lettedst.
Er ließe, he let, etc.

Perfect (Indic. and Subj.)

Ich habe gelaſſen, I have let.
Du haſt gelaſſen, thou hast let, etc.

Ich habe gelaſſen, I have let.
Du habeſt gelaſſen, thou hast let, etc.

Pluperfect (Indic. and Subj.)

Ich hatte gelaßen, I have let.
Du haſt gelaßen, thou hast let, etc.

Ich hatte gelaßen, I have let.
Du habeſt gelaßen, thou hast let, etc.

First Future (Indic. and Subj.)

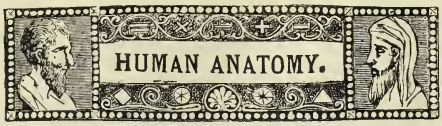
Ich werde laßen, I shall let.
Du wirſt laßen, thou wilt let, etc.

Ich werde laßen, I shall let.
Du werdeſt laßen, thou will let, etc.

Second Future (Indic. and Subj.)

Ich werde gelaßen haben, I shall have let.
Du wirſt gelaßen haben, thou wilt have let, etc.

Ich werde gelaßen haben, I shall have let.
Du werdeſt gelaßen haben, thou wilt have let, etc.



IV.

THE SKIN (*continued*).

The Cuticle or Scarf-skin.

THE protecting covering of the skin is distinguished from the layer we have just been considering (*see* p. 594) by being neither sensitive nor supplied with bloodvessels. It is a mass of substance always being shed in a dead condition, and as continually being replenished from beneath. A raw surface is one from which the whole of the cuticle has been removed for the time. It is often made evident to us in cases of blistering, where the greater part of the cuticle is lifted off from the true dermis by the pouring out of fluid. We then see that the cuticle is opaque, but a little translucent, and entirely without any trace of blood in it.

Cuticle shed and renewed.

When we look at a piece of scarf-skin without the aid of a microscope we may imagine it to be quite simple in structure, without distinct parts; but by microscopic study we learn that it is made up of a multitude of minute cells, which at the surface are very much flattened, like fish-scales. They are not merely closely packed together, but are glued by a sort of animal cement; at the surface, however, they continually fall off, or are rubbed off in washing, or in various ways, in small flakes, which consist of many scales.

Composed of flattened cells.

But the deeper part of the cuticle shows a change of structure where it approaches the true skin. The cells are less flattened and softer, until we come down to the base and find a row of perpendicular cells resting directly upon the dermis. These cells can be dissolved in acetic acid, while the upper ones cannot. The cells of the outer part of the cuticle may, however, be swollen to something of their original size by immersion in a solution of potash or soda; and this is what often happens to the hands of those engaged much in washing clothes.

Growing part of round cells.

It is in the deeper layers that new cells are continually being formed to replace those that are shed. The force which forms them is such that the mass of cells above is continually being raised. This consists of many rows of cells, although the thickness is not great, varying from the $\frac{1}{210}$th to the $\frac{1}{12}$th of an inch. The cuticle is much the thickest in the palms of the hands and on the soles of the feet, where the greatest pressure is usually experienced; but it will become thickened in any situation where there is excess of pressure or rubbing.

Varieties in thickness.

FIG. 7.—VERTICAL SECTION OF THE SKIN, SHOWING THE SWEAT GLANDS.

a, *b*, the epidermis, or cuticle; *e*, the pigmentum, or colouring matter of the skin; *d*, the rete mucosum, or gelatiniform layer situated beneath the epidermis; *c*, the corium; *f*, the subcutaneous areolar or adipose tissue; *g*, the sudoriferous glands; *h*, the convoluted duct of the sudoriferous glands conveying the sweat; *i*, the free surface of the skin.

The cuticle is moulded on the true skin, so that if it be perfectly withdrawn, it presents corresponding impressions of papillæ and furrows. There are also fine continuations from the cuticle into the sweat glands, and to form the hairs. Besides the fine ridges on the tips of the fingers, the cuticle shows larger markings, especially over the joints, where the skin must be extensive in order to cover the joint when it is most bent. These furrows also exist in the true skin. Fine lines are especially to be seen in the skin of the back of the hand, intersecting at all angles, and being either curved or straight.

Impressions due to dermis.

Furrows and lines.

The cuticle in its dry and scaly portions consists almost entirely of horny matter called keratin: it is closely allied to albuminous substances, and contains sulphur and a good deal of oxygen. It is insoluble in water, but can be dissolved by strong alkalis; water is imbibed by it on prolonged exposure, but will evaporate from it, leaving it as before.

The Colour of the Skin: Complexion.

Complexion is an affair depending on several particulars, including the thickness of the cuticle, its translucency, the abundance of fine bloodvessels in the true skin, and the amount of pigment present. Whiteness and pinkness of complexion belong to the former qualities; hue or colour proper depends upon colouring matter or pigment. It is a matter in which the cuticle alone is concerned.

Human pigment consists of nothing but very dark, fine, solid granules deposited in cells of the tissues, mostly in the deeper layers of the cuticle. The pigment in the cuticle appears to lose its colour as the cells containing it are pushed to the surface, but it does not entirely disappear. The different shades of the complexion are due to very slight differences in the colour of the pigment, and more considerable differences in amount in different persons and races. The depth of tint depends on the proportion between the coloured and the uncoloured cells. In both "coloured" and white races it appears that the colouring matter present is identical.

Pigment.

Shades of complexion.

The situation of a negro's colour may be seen when the skin is severely injured, as by a burn; a white scar is formed which only after some time becomes dark-coloured as the cuticle is formed

Colour of negroes.

over it. The use of the pigment is not very certain. It has been supposed to protect the true skin in some way from the sun's rays; but this cannot be the whole cause, as similar pigment is found in various situations in the interior of the body of many animals.

NAILS.

These important appendages belong essentially to the cuticle, and are both bloodless and senseless. They rest, however, upon highly developed regions of the dermis, possessing large papillæ and an abundant blood supply. The area of true skin upon which a nail is formed is called its *matrix*. At the base the matrix is deepest, forming a crescentic groove lodging the root of the nail. The greater part of the matrix has its papillæ arranged in rows corresponding to the length of the nail, and the rows are raised upon small ridges.

Developed on a sensitive and vascular matrix.

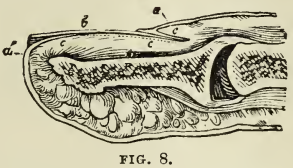


FIG. 8.

VERTICAL SECTION OF THE UNGUAL PORTION OF A FINGER, TO SHOW THE APPEARANCE OF THE NAIL.

a, the fold of epidermis at the base of the nail; *a'*, the epidermis, showing its continuity with the deepest layer of the horny lamina; *b*, the body of the nail; *c*, the duplicature of the skin, into which the nail is received; *c'*, the thick dermis, separating the nail from the phalanx.

The nail has its root concealed by the cuticle of the upper edge of the groove just mentioned; its body is quite free above; while in front there is a free edge. This in the savage state of mankind is naturally pared down by the many operations in which the nail is used, while in our artificial life the nail needs regular paring if it is not to present a cracked and ugly appearance.

Root of the nail.

The natural hue of the nail is a rosy pink, due to the blood contained in the matrix beneath; but in many persons a crescentic portion of the nail (the *lunule*) near the root is more or less white, owing to the irregular arrangement and smaller blood-supply of the papillæ beneath.

Lunule.

The nail is merely a more perfected and resisting portion of cuticle. It is composed of scaly cells in layers, cemented together by horny material. The cells are so closely pressed that at the surface they can scarcely be distinguished from one another. But the deepest cells, lying directly on the matrix, are soft and more rounded, just like the lowest portion of the cuticle.

Cells of the nail.

A notable peculiarity of the nail is that while new cells are constantly being formed all over the matrix, pressing upon those previously formed, this process is much more active at the root of the nail and in the groove which contains it. Thus the nail is gradually pushed forwards, while at the same time the new growth in front increases the thickness, so that the nail is thickest where it becomes quite free.

Growth at the root.

Sometimes an injury causes a dark-red or purple mark beneath a nail. This is due to the bursting of some of the finest blood-vessels, and the exudation of blood into the matrix or on its surface. If a nail comes off by reason of disease or injury, a new one will grow, provided that the matrix is not destroyed.

Corns are a kind of exaggeration of both parts of the skin. They arise solely from pressure which is excessive at a particular spot. A group of papillæ of the skin become very irritable and more or less wasted, and they need an additional protection. This is given by an extra growth of cuticle, which is more horny, more cemented together, and with the cells approaching closely to true horn. There is often a raised circular ridge, within which the tender papillæ, like a "core," are situated, and covered by a more or less separable cap. A *wart* contains a number of enlarged papillæ covered by a thickened cuticle.

Corns caused by pressure.

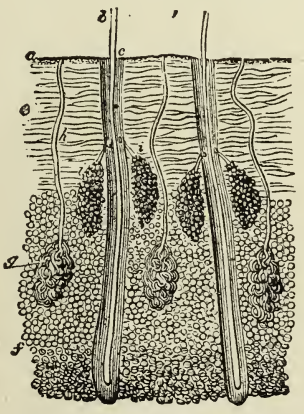


FIG. 9.

A SECTION OF SKIN FROM THE HEAD, SHOWING THE ROOTS OF THE HAIR AND THE SEBACEOUS FOLLICLES.

a, the horny layer of the cuticle *e*, the mucous layer; *g*, the sudoriferous glands; *h*, the sweat ducts proceeding from the sudoriferous glands to open on the surface of the skin; *f*, adipose cellular tissue; *b*, a hair, showing its projection above the skin; *c*, the hair follicle.

HAIRS.

Among the structures belonging to the cuticle, none is more important or characteristic than the thread-like protrusions known as hairs. They are found in many animals which have no backbone, and among those which possess a backbone; they are especially found in the mammals or those that suckle their young. Man's hairy covering, although more scanty than that of many mammals, is by no means the most reduced form to be met with among those creatures to whom he is allied in structure.

Characteristic of mammals.

A hair simply consists of essentially the same cells as the rest of the cuticle; but the cells are specially moulded upon a process of the true skin, and by its passage through a cylindrical canal. Every hair comes out of a pit called a hair-follicle,* and the lower end of the hair, in the follicle, is dilated like a bulb. The follicle itself resembles a long

Follicles of hair.

* Lat. *folliculus*, a little bag.

flask with a slender mouth; in the base of it there is situated a large conical papilla of the true skin, abundantly supplied with bloodvessels. This papilla is much larger than the ordinary papillæ of the skin, and is more deeply placed; the precise depth varies with the size and strength of the hair. Large hair-bulbs reach right down through the true skin into the fatty layer under it, and cells of the cuticle line the follicle all the way down.

With papillæ.

The papilla of the hair is clothed with large many-sided cells which can multiply, and continually do so, while the hair lives. Thus the bottom of the flask is filled with cells thus produced, which press upon one another; and the oldest portions are pressed by the growth below upwards into the neck of the flask, and so the hair is constituted of these cells plastered together.

Growth of the hair.

Under the microscope the outside of a hair is seen to be covered with fine overlapping scales; this is the hair-cuticle. Within this is the fibrous substance which usually constitutes most of the hair; it is really made up of small dry fibres pointed at each end, which are the result of the elongation of the originally soft cells of the bulb or root. The fibrous portion of the hair gives it its colour, which is due to small patches of colouring matter scattered in the cells. Very minute air-cavities are often formed as well, and they are particularly abundant in white hairs, while dark ones are nearly destitute of them. Some hairs have in addition a softer substance along their axis, called the *pith;* it is composed of soft cells, these often including small air-cavities.

Cuticle and fibres of hair.

Colour.

Small bundles of non-striated muscular fibres are usually found attached to the hair-follicles, and also to the surface of the true skin on one side of the hair. The direction is oblique, and the effect of the muscular contraction is to pull the hair-bulb towards the surface of the skin where the fibres are attached. Thus the part of hair outside the follicle will be carried in the opposite direction. As the muscle is usually attached beneath the hair, which lies more or less flat on the skin, the muscular contraction tends to raise the hair to the vertical position, the extent of the elevation being partly dependent on the rigidity of the particular hair moved.

Elevation of hair by muscular fibres.

A complete coating of soft hairs grows on the body before birth, and a portion of them are even shed previous to that event. Afterwards there is a natural process of growth and renovation of hair at intervals. The death of an old hair is signalised by an increased growth at the base after a period of rest. A line of separation is formed between the new growth and the old, and the vigorous and rapid increase of cells detaches the old hair from the papillæ and pushes it upwards in the follicle. The new hair becomes fully formed by the lengthening of its cells like those of the old one. The old hair is gradually pushed out; but economy is practised: its root still contains useful soft material, so a good deal of it is absorbed into the system, being dissolved and carried away by the blood-vessels or lymphatics of the true skin surrounding it.

Hair before birth.

Death and renewal of hair.

XXXIX.

THE VERB.

III. Model of a verb in *eter*, doubling the *t* before *e* mute, which may also serve for verbs in *eler*, doubling *l*.

INFINITIVE.

Present—jeter, *to throw*. *Past*—avoir jeté, *to have thrown*.

PARTICIPLE.

Present—jetant, *throwing*. *Past*—jeté, *thrown*, ayant jeté, *having thrown*.

INDICATIVE.

Present.		*Perfect Definite.*	
je te le jette	*I throw it to thee, etc.*	je te les jetai	*I threw them to thee, etc.*
tu me le jettes		tu me les jetas	
il nous le jette		il nous les jeta	
nous le lui jetons		nous les lui jetâmes	
vous le leur jetez		vous les leur jetâtes	
ils vous le jettent		ils vous les jetèrent	
Imperfect.		*Future Absolute.*	
je te la jetais	*I was throwing it to thee, etc.*	je t'en jetterai	*I shall throw some to thee, etc.*
tu me la jetais		tu m'en jetteras	
il nous la jetait		il nous en jettera	
nous la lui jetions		nous lui en jetterons	
vous la leur jetiez		vous leur en jetterez	
ils vous la jetaient		ils vous en jetteront	
COND. *Present.*		IMPERATIVE.	
je t'y jetterais	*I would throw thee into it, etc.*	jette-le-moi	*throw it to me, etc.*
tu m'y jetterais		qu'il te la jette	
il nous y jetterait		jetons-les-lui	
nous l'y jetterions		jetez-leur-en	
vous les y jetteriez		qu'ils vous y jettent	
ils vous y jetteraient			

SUBJUNCTIVE.

Present.		*Imperfect.*	
que je jette	*that I may throw, etc.*	que je jetasse	*that I might throw, etc.*
que tu jettes		que tu jetasses	
qu'il jette		qu'il jetât	
que nous jetions		que nous jetassions	
que vous jetiez		que vous jetassiez	
qu'ils jettent		qu'ils jetassent	

IV. Model of a verb in *er* whose final syllable is preceded by an *e* mute. The verb *mener*, which is selected, may serve also for those verbs in *eler* and *eter* which are excepted from the general rules *a* and *b*.

INFINITIVE.

Present—mener, *to lead*. *Past*—avoir mené, *to have led*.

PARTICIPLES.

Present—menant, *leading*. *Past*—mené, *led*, ayant mené, *having led*.

INDICATIVE.

Present.	*Perfect Definite.*
je mène, *I lead, etc.*	je menai, *I led, etc.*
tu mènes	tu menas
il mène	il mena
nous menons	nous menâmes
vous menez	vous menâtes
ils mènent	ils menèrent

Imperfect.		*Future Absolute.*	
je menais	*I was leading, etc.*	je mènerai	*I shall lead, etc.*
tu menais		tu mèneras	
il menait		il mènera	
nous menions		nous mènerons	
vous meniez		vous mènerez	
ils menaient		ils mèneront	

COND. *Present.*		IMPERATIVE.	
je mènerais	*I should lead, etc.*	mène	*Lead thou, etc.*
tu mènerais		qu'il mène	
il mènerait		que Jean mène	
nous mènerions		menons	
vous mèneriez		menez	
ils mèneraient		qu'ils mènent	

SUBJUNCTIVE.

Present.		*Imperfect.*	
que je mène	*that I may lead, etc.*	que je menasse	*that I might lead, etc.*
que tu mènes		que tu menasses	
qu'il mène		qu'il menât	
que nous menions		que nous menassions	
que vous meniez		que vous menassiez	
qu'ils mènent		qu'ils menassent	

Remark.—*Mener* is also rendered by *to take;* and compared from that point of view with *porter*, it implies the fact that some person or animal, using his own powers of locomotion, is being taken or led to some place; whereas *porter* means carried bodily,

mener, *to take, lead*
remener, *to take back*
amener, *to bring to*
ramener, *to bring back again to*
emmener, *to take along*
remmener, *to take back again with one.*

porter, *to take, carry*
reporter, *to take back*
apporter, *to bring to*
rapporter, *to bring back again to*
emporter, *to take away*
remporter, *to take away again with one.*

EXERCISE XLVII.

1. The conductor (*chef d'orchestre*) is calling the first violins around (*autour de*) him. He will call them for-a-long-time (*longtemps*): they are on strike (*en grève*). 2. The bell (*la sonnette*) recalls (*rappeler*) the musicians to the orchestra. 3. Were not the bells (*cloches*, f.) calling us to church (*l'église*)? 4. She called the drummer in a whisper (*à voix basse*), and repeated to him the bugler's words (*paroles*). 5. The horn-player will cuff the clarionet-player, because the latter (*parce que celle-ci*) called (*perf. indef.*) him *a* brayer. 6. The guitar-player was painfully (*péniblement*) spelling his part (*partie*, f.), and the harpist was running through a book of music (*un cahier de musique*). 7. Do (*donc* after verb) muzzle your dog; the neighbour is about to (*see* p. 236, vol. i.) play on the trombone. 8. The piper was renewing his efforts; how (*comme*) this poor piper pants! he is done up (*n'en peut plus*). 9. Will this violinist reject all the offers of the manager (*toutes les offres, régisseur*)? 10. Does Mr. X., the violoncellist, intend to (*de*) give a concert? Indeed-he-does (*en effet*); he spoke (*perf. indef.*) to me of a *matinée* which (*qu'*) he has the intention of organising (*organiser, infinitive*). 11. The pianist is rummaging everywhere (*partout*); he has mislaid (*égaré*) his spectacles (Voc. XII.); the leader (*chef d'attaque*) of the altos shows (*montrer*) them to him. 12. The-flautists-will-require-to (*il faudra que* the flautists may) repeat their part; they do not know (*posséder*) it yet. The-double-bass-must-not (*il ne faut pas que* the double bass may) repeat his aloud (*à haute voix*). 13. Does Mr. Z. play the hautboy well? He-does-not (*il n'*) play it badly; he would play it better if he possessed (*imperf. indic.*) rhythm (*le sentiment du rythme*). 14. Oh! (*tiens*), here is a harp. Who (*qui est-ce qui*) plays (of) it?—Mlle. B——.—Does she play it well?—She will play it in the course of the evening (Voc. XV.); you will judge (*juger*). 15. Wretched man (*malheureux*), what (*qu'est-ce qui*) drives (*pousser*) you to play the accordion? Play rather on the reed-pipe, the jew's-harp, or anything (*de n'importe quoi*). 16. Take the hurdy-gurdy player to the kitchen in-order-that (*pour qu'*) he may refresh himself (*s'*) there; carry *for* (to) him his hurdy-gurdy, he is done up. 17. If we take back the hautboy to the refreshment-table (*buffet*, m.) he will take back his thirst to it; let us rather take him along to the cloak-room (*vestiaire*, m.). 18. Bring us that famous virtuoso (*fameux virtuose*), and beg him to (*prier . . . d'*) bring his instrument with (*avec*) him, in order that he may play (of it) to us. 19. Take back again the big-drummer to the barracks (*caserne*, f. s.), and take the kettle-drummer along with (*avec*) you. 20. Since (*puisque*) you have brought the town's brass-band (*la fanfare de la ville*) to us, you can also (*pouvez aussi*) take it back again.—But the instruments?—Those who brought them (*ceux qui les ont apportés*) will carry them back again, that's all (*voilà tout*).

EXERCISE XLVIII.

1. Boileau dit: "J'appelle un chat un chat et Rollet un fripon (*rogue*)." C'est (*this is*) appeler les choses (*things*) par leur nom. 2. Le génie de Turenne l'avait appelé au commandement des armées: ce guerrier célèbre mourut le visage tourné vers l'ennemi. 3. Richelieu, appelé dans les conseils du roi, en "fit bientôt à sa tête" (*to have one's own way*). 4. Au moment d'atteler, le cocher (*coachman*) se (*to himself*) donna un coup (*blow*) à la tête qui le fit tomber (*to cause to fall*) à la renverse (*backwards*). 5. Il attela des rois au char de ses victoires (V. Hugo). 6. Il faut que les domestiques époussettent mes habits (*not* m'époussettent les habits). 7. J'ai vu le Rhône: le cours en est souvent impétueux. 8. Quand on est dans un pays, il faut en suivre les usages (*one must follow . . . customs*). 9. La gaieté (*cheerfulness*) est la santé (*health*) de l'âme, la tristesse (*sadness*) en est le poison. 10. Deux jours entiers (*whole*), jetant sa nourriture (*food*), il haleta sous un ciel embrasé (*burning sky*—Millevoye). 11. La science doit avoir de grands ménagements avec (*must be full of consideration for*) l'ignorance, qui est sa sœur ainée (Fontenelle). 12. En automne, les arbres perdent leurs feuilles (*to lose, leaves*). 13. Est-ce sa goutte (*gout*) qui le retient (*keeps*) chez lui? 14. Baissez (*cast*) vos yeux vers la terre, chétifs vers (*puny worms*) que vous êtes (Pascal). 15. Et moi, je ne crois (*think*) pas qu'il soit digne (*worthy*) du peuple en qui Dieu se reflète de joindre (*to join*) au bras qui tue (*kills*) une main qui soufflette (V. Hugo). 16. Le sommelier (*butler*) s'est blessé à la main en cachetant les bouteilles (*bottles*). 17. Comme (*as*) l'esprit de vin (Voc. IV.) ne gèle jamais, on fait usage (*one uses*) du thermomètre à alcool en Sibérie (Babinet). 18. Le froid excessif lui a gelé le nez. 19. Mon poing (Voc. XV.)

désarmé (*unarmed*) martèle les armures mieux qu'un chêne noueux (*knotty*) choisi (*picked*) dans les forêts (V. Hugo). 20. Il n'y a pas de plume (*pen* for *author*) plus leste (*lively*), plus gaie, plus folle, que lui.

EXERCISE XLIX.

1. In (*en*) calling a spade (*cat*) a spade one calls things by their name. 2. Louis XIV. had called Colbert into (*dans*) his councils (*conseils*); everything was prospering (*tout, prospérer*). 3. (The) people (*gens*, pl.) were believing (*croyaient*) that they could be bewitched (*qu'on pouvait* bewitch them), and imagination was bewitching them indeed (*effectivement*). 4. The coachman hurt his (*se fit mal* at the) knee in falling backwards. 5. Ceres was presenting (*Cérès, présenter*) to (the) men a plough (*charrue*, f.), and was-causing-oxen-to-be-yoked (*faisait . . . des bœufs*). 6. La Fontaine is my favourite author (*auteur favori*); I love his simplicity (*naïveté*, f.), his archness (*malice*, f.), and his Gaulish humour (*esprit gaulois*). 7. Time flies (*le temps fuit*), its loss is irreparable (*perte*, f., *irréparable*). 8. The country has its charms (*campagne*, f. *agréments*); its pleasures are numberless (*plaisirs, sans nombre*). 9. The Amazon is a huge river; all travellers marvel at the fertility of its banks (*Amazone, rivière, immense, tous les voyageurs s'extasient de la fertilité, bords*). 10. A divine fire (*feu divin*) sparkles in the eyes of the young warrior (Fénelon). 11. She had at the end (*bout*, m.) of her sleeves (*manches*) a pair of hands so white (*si blanches*), that I should in sooth have liked to be cuffed by them (*que je voudrais en vérité . . . avoir été* cuffed —Scarron). 12. From (*depuis*) the eve of Palm-Sunday (Voc. XIV.) to the second (*jusqu'à la seconde*) festival of Easter, it was lawful (*permis*) in the town of Béziers to (*de*) cuff all the Jews that one met (*qu'on rencontrer*, imperf. indic.). 13. How have the thieves penetrated into the instrument-maker's shop (*comment, voleurs, pénétrer, dans la boutique*)? By the door, after having (inf. pres.) picked the lock (*serrure*, f.). 14. I have soiled (*sali*) his hand with ink (*de l'encre*). She has soiled my handkerchief (*mouchoir*, m.) with ink. 15. Is it her sick-headache that keeps her at home as usual (*comme de coutume*)? 16. I never saw you so before (*je ne . . . ai jamais vu ainsi*); what is wrong with you (*que . . . manque-t-il*)?—I have toothache. 17. Take care, you are going to burn your fingers with this sealing-wax (*prenez garde, vous allez . . . brûler . . . doigts, avec cette cire à cacheter*); here are (*voici*) wafers (*pains à cacheter*). 18. The excessive cold had frozen their feet. 19. They heap up the sheaves (*gerbes*); they heaped them up; will they heap them up? would they not heap them up? 20. There never was in the foreign-office a (*il n'y a jamais eu au ministère des affaires étrangères de*) better head than his.

By ENOCH GREGOR LEA.

I.

The Steam Engine.

The marvellous power and universal adaptability of the steam engine in one form or another are subjects that are so familiar now-a-days that they excite no surprise. The reader, however, will probably allow that this familiarity, so far as the steam engine itself is concerned, extends no further than to general appearances. It will be our endeavour to describe as concisely as possible those parts that are hidden from the eye of the observer, and to so explain the principles upon which the various contrivances are constructed, that the reader shall be able to intelligently examine any engine that he may have the opportunity of inspecting, and so fill in for himself the many details that space forbids us from entering upon.

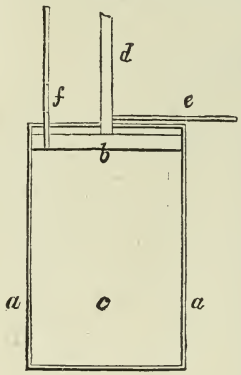


FIG. 1.

In order to explain the fundamental principles that determine the form and action of the steam engine, it will be necessary to use a few illustrations. If we were to take a piece of tube closed at one end, and pack into the closed end a quantity of gunpowder, and to push a bullet down on to it, and then by any means to set fire to the gunpowder, we should have the bullet driven along the tube, and thence through the air, with great force. Such, indeed, is well known as the action of fire-arms, from the smallest pocket pistol or toy cannon to the hundred-ton gun. But how is it that so harmless a looking substance as gunpowder has this great power? Merely because it is so made that when ignited it produces a quantity of gas occupying more than two thousand times the space of the powder itself. This enormous increase in bulk drives the bullet forward to make room for itself with such suddenness and power, that if the bullet will not move with sufficient ease, the best gun that has ever been constructed will be burst.

We see here, then, that by converting a solid substance into a gas we get an enormous increase in its bulk, and that if this change is brought about in a tube closed at one end, we get a correspondingly great pushing force. In the gun this pushing force is developed almost instantaneously, by the sudden conversion of solid gunpowder into gaseous products. In the steam engine a similar pushing force is developed gradually by the comparatively slow conversion of water into steam. The power, or pushing force as we have called it, that is produced by this change, is admirably illustrated

by the impetuous rush of steam from the spout of a kettle of boiling water, or, if the vapour cannot make an exit otherwise, the ease with which it will lift the lid or drive a copious stream of water through the spout, to allow for the great increase in bulk that is produced. It is interesting to notice that water is but little inferior to gunpowder when viewed merely as a force-producing agent by its conversion into steam—for a pint of water will furnish rather more than sixteen hundred pints of steam, while a pint of gunpowder yields about two thousand pints of gaseous products. It must be borne in mind, however, that the powder does its work instantaneously, by the action of a single spark, and the water gradually, by the continued application of heat to it.

If, now, we take the tube before mentioned, closed at one end, and put into it a little water, and then the bullet, taking care that it fits the tube nicely, and will slide up and down without much friction, we have a similar arrangement to the first, but the quick-acting gunpowder has been replaced by the slow-acting water. On applying heat to the water, the bullet or plug will be gradually but surely driven along the tube.

The first apparatus that really deserves the name of a steam engine was constructed by Denis Papin, in the year 1690, and was exactly like the arrangement just described, except that the tube was much wider in proportion to its length than a gun-barrel, and the bullet was replaced by a carefully fitting plug. Fig. 1 is a representation of this engine.

The tube *a c* is called the *cylinder*, and the plug *b* the *piston*. If a layer of water were introduced into the cylinder *c*, and the piston thrust down upon it, and then heat applied to the bottom of the cylinder, the steam developed would push up the piston, and also anything attached to the *piston-rod*, *d*. If, now, the fire were withdrawn and the apparatus cooled, the steam would shrink into its original bulk of water, and the piston being robbed of its support, would fall to the bottom of the cylinder. This simple piece of mechanism—namely, the cylinder with its piston, which is pushed to and fro in it by the steam, and the piston-rod which communicates this motion to apparatus outside the cylinder—may be considered the most important part of every steam engine, the actual power-producing portion.

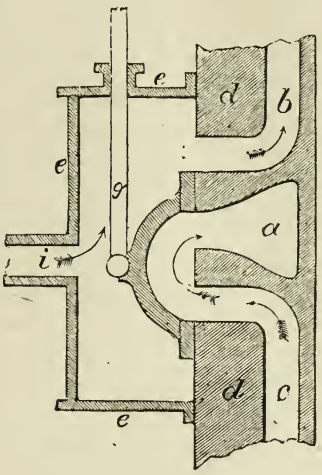


FIG. 2.—THE SLIDE VALVE.

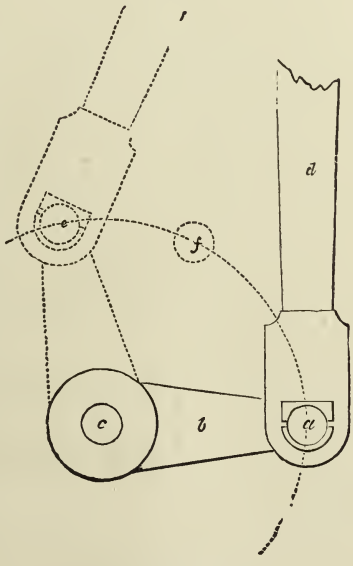


FIG. 3.—THE CRANK.

During the latter half of the last century, the celebrated James Watt was accidentally brought to consider the crude steam engines then in use, and his genius and wonderful perseverance made so many improvements in them, that he may justly be called the inventor of the steam engine. Speaking generally, we may say that all the improvements that have been effected since his time are developments of his inventions. We will therefore now proceed to examine the various parts of the steam engine as at present constructed, making the simple apparatus figured above our starting-point.

The steam is no longer prepared in the cylinder itself, but in a separate and much larger vessel called the *boiler*, constructed so that it may with safety stand the great internal pressure to which it may be subjected. Speaking roughly, the boiler should never be more than half full of water, so that the other half may form a reservoir in which the steam may accumulate, and the surface of the liquid be sufficiently removed from the steam pipe to prevent splashes of water from being carried into it. A further description of the appliances that belong more especially to the boiler will be given in the chapter on the Locomotive, to which the reader is referred.

The cylinder of the modern engine is far more perfect than the one figured above, inasmuch as the steam, after it has forced the piston to the top of the cylinder, is by an automatic arrangement caused to enter above the piston and to drive it down again. By this means its action becomes independent of any arrangement for condensing the steam that has done its work—although, as we shall presently see, it is possible by the use of a condenser to materially add to the power developed and at the same time to decrease the consumption of fuel. The upper end of the cylinder is provided with a cover, through the centre of which the piston-rod passes, the

escape of steam being prevented by the use of a *stuffing-box*. The stuffing-box is used wherever it is necessary for a rod to connect an internal with an external part of the engine, and is nothing more than a small chamber which surrounds the rod, packed with tow or a similar material, with a ring that is screwed down into it to press the packing tightly against the sides of the rod.

There are two principal methods by which the steam is directed alternately into each end of the cylinder, the most important of which involves the use of a *slide-valve*. An ordinary form of slide-valve with the adjacent parts is shown in section in fig. 2.

The side of the cylinder, marked *d d*, is made extra thick to allow of the steam ways *a*, *b*, and *c* being cut in it. These passages open into the *valve-chest* marked *e e e* through three openings, or *ports*, in the smooth level surface over which the slide-valve is moved by its rod *g*. The passages marked *b* and *c* lead respectively into the upper and lower ends of the cylinder, and the action of the valve is by its sliding motion to connect these passages alternately with the *exhaust*, or opening for the spent steam, marked *a*, leaving the one not so connected free for the passage of the steam from the valve-chest to the cylinder. Thus, when the apparatus is in the position shown in the diagram, the steam from the boiler enters at *i* and passes through *b* into the upper end of the cylinder, and so forces the piston down, while the steam below the piston escapes through *c* into the exhaust *a*, as shown by the arrows. The piston is thus driven downwards in the cylinder, but the rod of the slide-valve is so connected that the valve is simultaneously drawn upwards until, by the time the piston has arrived at the bottom of the cylinder, the valve has connected the upper passage *b* with the exhaust, and left *c* open to the full pressure of steam from the boiler. By this means we have the piston *pushed* by the steam from end to end of the cylinder; and an engine whose power is derived merely from the pushing force of the steam, has its exhaust open to air, and the used steam escapes from it in the familiar puffs. Such engines are called *high-pressure* or *non-condensing*.

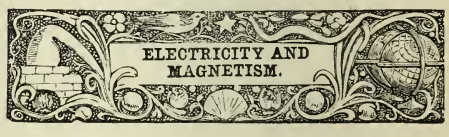
If, instead of allowing the used steam to escape into the air, it is conducted into a closed vessel and there cooled, it will shrink into its original small bulk of water; and as the apparatus being closed prevents ingress of air, we shall obtain a more or less complete vacuum in that end of the cylinder towards which the piston is being driven. This vacuum exercises a sort of sucking force, so that we may imagine the piston being pulled by the vacuum on one side, while it is being pushed by the steam on the other. It is obvious, then, that a less pressure of steam will be necessary for the same amount of work, because that pressure is supplemented by another force. Hence, engines made with *condensers* are called *low-pressure* engines. Some condensers consist merely of a vessel surrounded by cold water, into which the steam passes, with an arrangement of pumps worked by the engine itself, to remove the water produced by the condensation of the steam and keep up a constant flow of cold water in the outer casing. Others cool the steam by sending a spray of cold water into it; while a third variety consists of a coil of pipes through which the steam passes, kept cool by water trickling over it. It is obvious that the water used to keep the condenser cool must itself get heated, and if this warm water is used to feed the boiler, an amount of fuel will be saved corresponding to that which would be necessary to raise an equal quantity of cold water to the same temperature.

So far we have investigated the cylinder and the apparatus that more directly appertains to it, and seen how the piston-rod is forced alternately backwards and forwards. But steam power would be of very limited application if we could not convert these oscillations into a circular motion. This end is attained by the use of a very simple device, the *crank*, which is familiar to every one who has examined a grindstone or sewing machine worked by means of a treadle.

Fig. 3 illustrates the ordinary form of crank.

The simplest method by which the movements of the piston-rod are communicated to the crank is by means of the *connecting-rod*, one end of which as it were grasps the crank, while the other end is hinged to the piston-rod. It needs but little thought to see that with the crank in the position shown in the diagram, the upward movement of the piston would thrust the crank round until it was above instead of below the shaft that it is connected with, and that then neither the pushing nor the pulling force that the piston could exercise would be able to affect it. The power that the piston-rod has to move the crank is greatest when they are at right angles to each other, and gradually diminishes with the rotation of the crank, becoming *nil* when they are in the same line. The two positions in which the piston is powerless to affect the crank are called the *dead points*.

The crank pure and simple, therefore, is a most imperfect piece of mechanism, as in every single revolution it twice attains its maximum velocity and twice comes to a standstill.



XX.

MAGNETISM (*continued*).

FOR the measurement of magnetic declination and inclination two very ingenious instruments have been devised, a description of which will now be given.

Magnetic measurements.

The first of these, the so-called declination compass, is shown in fig. 66. It consists of a brass or copper box, M N, in the bottom of which is a divided circle. In the centre of this circle is

The declination compass.

suspended upon a very delicate pivot by an agate cap, a small lozenge-shaped magnetic needle. The box M N, is itself mounted upon a copper circle, P Q, divided into degrees, and upon which it is freely movable. P Q is supported upon a tripod stand, which is mounted upon levelling screws. To the box M N two uprights are attached, and through these a horizontal axis, *a a'*, passes and supports a telescope, L L', which can be moved in a vertical plane. Beneath *a a'* is a spirit-level, S, by which the accuracy of the adjustment of the tripod stand may be tested. The box, M N, moving on the graduated table, P Q, of course carries the telescope with it, and the number of degrees through which the telescope is moved horizontally is measured upon P Q (which is called the *altazimuth circle*) by a vernier. Another vernier also registers upon a fixed graduated vertical arc the number of degrees through which the telescope is moved in a vertical direction.

How the compass is used.

In working the instrument, it is first placed in a perfectly horizontal position by means of the spirit-level and the levelling screws attached to the feet of the tripod stand. The next thing is to find the astronomical meridian, by methods which are explained in the papers on Astronomy. The box M N is next turned until the telescope is in this astronomical meridian. The angle made by the magnetic needle with the diameter, *n s*, of the box, M N, and which corresponds with the zero of the scale, and is exactly in the plane of the telescope, is read off on the graduated circle. If the north end of the needle stops east of *n s*, the declination is so many degrees east; if it stops on the west side of *n s*, the declination is so many degrees west.

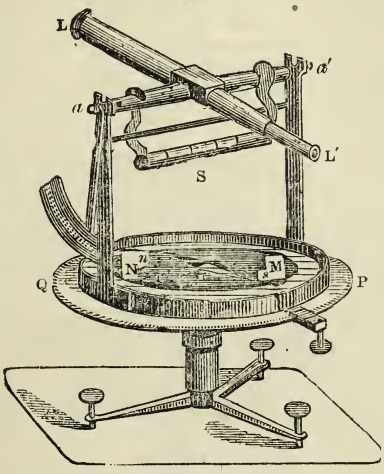


FIG. 66.—DECLINATION COMPASS.

These observations are, however, only correct when the *magnetic axis* (that is, the line joining the two magnetic poles) of the needle coincides with the line connecting its two ends, or its *axis of figure*. This is very rarely the case, and it is therefore usual to reverse the needle in such a way that its under surface is placed uppermost, and to proceed as before. The mean of the two observations is then taken as the true declination.

The inclination compass.

The second important instrument is one for measuring the inclination, or dip, of the magnetic needle, and is known as the *inclination compass*. It is represented in fig. 67. Here A B is a graduated circular stand, resting upon a tripod stand, supported by levelling screws, and provided with a spirit-level. Moving freely upon this stand is a plate, C D, which replaces the metal box of the declination compass. This plate supports, by means of two uprights, a graduated circular hoop, E F. Between the uprights, and supported by them, is a frame, on which a needle is pivoted so that it can move only in a vertical plane. The axis upon which the needle swings is of very fine steel, and is supported by two horizontal triangles attached to the frame.

Use of the inclination compass.

In using the instrument the magnetic meridian is first ascertained. This is done by turning the plate, C D, upon A B until the needle is vertical, which will of course be when it is in a plane at right angles to the magnetic meridian. The plate is then turned 90°, which will bring the needle into the magnetic meridian. The angle which the needle now makes with the horizontal diameter of the vertical graduated ring is the inclination.

Possible errors.

Several errors may creep into observations made by this instrument, and of these the three following are the most important. First, an error may arise owing to the magnetic axis not coinciding with the axis of figure of the needle; and this may be remedied, as in the declination compass, by reversing the needle and taking the mean of two observations. The second error arises if the centre of gravity of the needle does not coincide with the point through which the axis of suspension passes. This error is guarded against by demagnetizing the needle and then remagnetizing it in such a way that its poles are reversed. The mean of two observations, one made before and the other after the change of polarity, is then taken as the true inclination. The third error exists when the plane of the vertical ring does not coincide with the true magnetic meridian. It should be in that plane when the needle has its minimum deviation; an observation of this kind is usually taken along with that described above, by which the needle is moved 90° from its maximum deviation.

The mariners' compass.

An instrument which we must by no means omit to describe is the well-known and invaluable mariners' compass. This is represented in fig. 68. It consists of a cylindrical case, which, in order that it may be kept horizontal during the rolling of the vessel, is supported by two concentric rings, called *gimbals*. Of these, the inner is attached to the case itself, and moves about an axis which plays in the outer ring, which again moves about an axis at right angles to the first. The needle is mounted on a pivot in the centre of the box, and rests on an agate cap. Above this is fixed a very thin disc of mica, the diameter of which is slightly

greater than the length of the needle. This disc has traced upon it a star or *rose* having thirty-two branches showing the eight points of the wind, the half points, and the quarters. The branch ending with a small star corresponds to the magnetic needle beneath.

The Astatic needle.

A system of two magnetic needles, called an *Astatic needle*, is of great use in magneto-electric apparatus, and will be frequently referred to in these pages. A brief description is therefore necessary. In fig 69 this combination is represented. It consists simply of two freely suspended magnetic needles, *a b* and *a' b'*, joined together so as to be parallel with each other, but with the north pole of one over the south pole of the other. By this arrangement the directive action of the earth upon the magnets is neutralized, and the system sets at right angles to the magnetic meridian.

Intensity of earth's magnetism.

The intensity of the earth's magnetism may be measured by the number of oscillations performed by a magnetic needle after it has been removed from its position of equilibrium. If the same magnetic needle be taken to two or more places upon the earth's surface, and be in each place moved from the magnetic meridian, it will, after a certain number of oscillations, return to its original position; the number of oscillations thus made will, however, be different in each place. These oscillations are similar in character to the movements of the pendulum, and are governed by analogous laws. By these laws we know that the intensity of the earth's magnetism at any two places is proportional to the square of the number of oscillations performed in a given time. Suppose the number of oscillations at two different places to be respectively 28 and 30, then the relative intensity of the earth's magnetism at these places will be in the proportion of 784 to 900, or the magnetic intensity at the latter place to that at the former will be as 1·148 to 1.

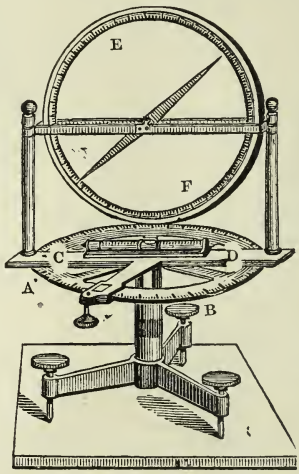


FIG. 67.—INCLINATION COMPASS.

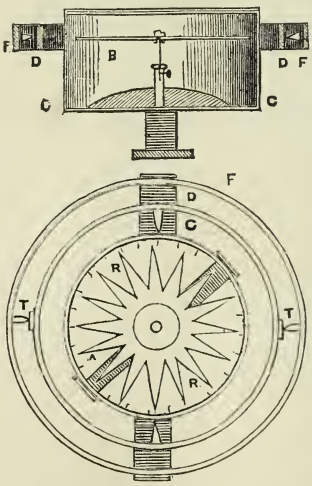


FIG. 68.—MARINERS' COMPASS.

Magnetic attraction and repulsion.

When the force of magnetic attraction and repulsion is quantitatively examined, it is found to vary in the same way as the force of electrical attraction and repulsion. That is to say, the attraction or repulsion *varies inversely as the square of the distance*—a law the meaning of which has already been sufficiently explained.

This law was first conclusively proved and formulated by Coulomb, who proved it both by the method of oscillations and by his torsion balance, an instrument which we will now describe.

Coulomb's torsion balance.

This ingenious apparatus is represented in fig. 70. It consists of a glass case, covered with a glass lid, in which latter is a small aperture, through which a magnet may be introduced. Upon the top of the glass lid is a glass cylinder, provided at its upper extremity with a micrometer. This micrometer is shown on a somewhat larger scale on the left hand of the diagram, and will be seen to consist of two circular pieces: D, which is divided on the edge into 360 degrees, while E, which is movable, carries a mark to indicate the amount of its rotation. Upon E are two uprights, through which passes a screw which supports by a fine silver wire a magnetic needle, *a b*. Round the sides of the glass case, about half-way up and on a level with the suspended needle, a paper scale of degrees is placed. The zero of this scale and the suspended magnetic needle are so arranged that when the mark on E is at zero of the micrometer, they are in the magnetic meridian.

The needle is then removed and replaced by one of some unmagnetic substance, such as copper; the tube, and with it the micrometer, is turned so that the needle stops at the zero of the paper scale on the case. The magnetic needle is now replaced, and is exactly in the magnetic meridian, so that the wire exerts no torsion.

How the torsion balance is employed.

In using the instrument, the influence of the earth's magnetism upon the suspended magnetic needle, *a b*, when the latter is moved out of the magnetic meridian, must be ascertained. To do this, the micrometer piece, E, is turned until *a b* makes a given angle with the meridian. Coulomb, in one of his experiments, found that the piece, E, had to be turned 35° in order to move the needle through 1°—that is, the earth's magnetism was equal to a torsion of 35°.

The action of the earth's magnetism having thus been determined, the magnet A is placed in the case through the aperture in its lid so that the similar poles are opposed to each other, when repulsion of course results. In one experiment Coulomb found that this repulsion

drove the suspended needle through 24°. The force which tended to bring the needle into the magnetic meridian was therefore represented by $24° + 24 \times 35 = 864$. of which the part 24° was due to the torsion of the wire, and $24 \times 35°$ was the equivalent in torsion of the directive force of the earth's magnetism. The needle being in equilibrium, the repulsive force which counterbalanced those forces must be equal to 864°. The micrometer disc was then turned until $a\ b$ made an angle of 12°. In order to do this eight complete revolutions of the disc, or 2880°, were found to be necessary. The total force now tending to bring the needle into the magnetic meridian was composed of the 12° of torsion by which the needle was removed from its starting point, of the 2880° torsion of the wire, and of the force of the earth's magnetism represented by a torsion of $12 \times 35° = 420°$, making in all 3312°. But the torsion at 24° was only 864, which is about one-fourth the torsion at 12°. In this way Coulomb demonstrated that the forces of attraction and repulsion vary inversely as the square of the distance.

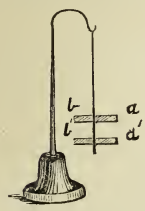


FIG. 69. ASTATIC NEEDLE.

Before leaving the subject of magnetism we must not omit to notice the manner in which magnetic properties may be imparted to steel bars, so as to convert them into artificial magnets. And this we shall proceed to do in our next article.

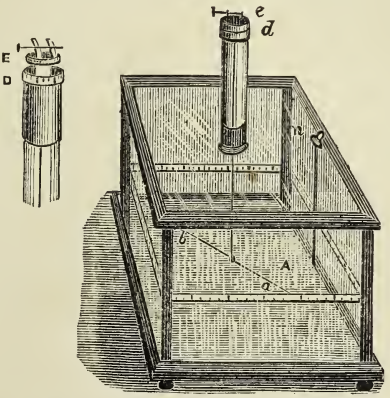
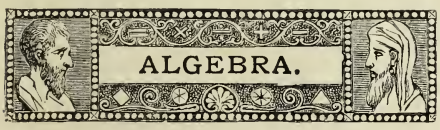


FIG. 70.—COULOMB'S TORSION BALANCE.]



III.

DIVISION.

a divided by b is written $a \div b$, or in the form of a fraction, $\frac{a}{b}$. $ac \div bc$ is written $\frac{ac}{bc}$. Now, here we have a fraction in which the letter c is a factor of both numerator and denominator; we may therefore divide both numerator and denominator by this factor c (*i.e.* we may omit it from both). Thus $\frac{ac}{bc} = \frac{a}{b}$. Similarly,

$$\frac{abc}{abd} = \frac{c}{d}, \text{ and } \frac{6a^3bc}{3a^2b^2c} = \frac{6a^2abc}{3a^2bbc} = \frac{2a}{b},$$

since the factors 3, a^2, b, c are common to both numerator and denominator. We now see the truth of the following rules:

Case I.—When the divisor and dividend are both simple quantities, write them as shown above, in the form of a fraction; omit any letters which may be common to both; and divide the numerical coefficients by their greatest common measure. The result is the quotient required. Its sign is determined in the same way as that of a product: *i.e.*, when the signs of dividend and divisor are like, the sign of the quotient is +; when they are unlike, it is −.

Thus: Divide $36abc$ by $3a$. $\frac{36abc}{3a} = 12bc$.

$$\frac{36abc}{24ad} = \frac{3bc}{2d}; \quad \frac{-36abc}{24ad} = -\frac{3bc}{2d}.$$

$$\frac{-36abc}{-24ad} = \frac{3bc}{2d}; \quad \frac{36abc}{-24ad} = -\frac{3bc}{2d}.$$

$$\frac{6xy}{12xyz} = \frac{1}{2z} \qquad \frac{3xy}{3x} = y.$$

The denominator of the quotient in this case is 1, which need not be written, because dividing by 1 does not alter the value of a number.

Case II. — When the dividend is multinomial, and the divisor simple, divide, according to the process just described, each term of the dividend by the divisor, and connect the results by their proper signs. Thus, divide $6ab - 9bc$ by $3b$; or, putting the same thing in a different form, find the value of $\frac{6ab - 9bc}{3b}$.

Proceeding according to our rule, we have $6ab \div 3b = 2a$, and $-9bc \div 3b = -3c$. Result, $2a - 3c$.

Divide $ax^2 + bx + c$ by x: we have $ax^2 \div x = ax$; $bx \div x = b$; $c \div x = \frac{c}{x}$, which we cannot simplify. Result, $ax + b + \frac{c}{x}$.

Similarly, $\frac{x^3y + x^2y^2 + xy^3}{xy} = x^2 + xy + y^2$.

If any power of a quantity is to be divided by any other power of the same quantity, subtract the index of the divisor from the index of the dividend. The reason for this rule is easily seen in a simple case. Suppose we have $a^5 \div a^3$. This is the same as $\frac{a^5}{a^3}$ or $\frac{a \times a \times a \times a \times a}{a \times a \times a}$. If we divide numerator and denominator of this fraction by $a \times a \times a$, it becomes $\frac{a \times a}{1}$ or a^2. Thus $a^5 \div a^3 = a^{5-3}$. By similar reasoning we find that $\frac{a^m}{a^n} = a^{m-n}$, m being supposed greater than n.

For $\frac{a^m}{a^n} = \frac{aaa \ldots \text{with } a \text{ written } m \text{ times}}{aaa \ldots \text{with } a \text{ written } n \text{ times}}$, and we can divide both numerator and denominator of this fraction by the factors common to both. Evidently n factors each equal to a, are common to both. Dividing the numerator by them, the quotient is $m - n$ factors, each equal to a; and dividing the denominator, the quotient is 1. Thus—

$$\frac{a^m}{a^n} = \frac{a^{m-n}}{1} = a^{m-n}.$$

By this rule we have $\frac{a^2}{a^6} = a^{2-6} = a^{-4}$. But what does a to the power -4 mean? Consider how it was obtained.

$\frac{a^2}{a^6} = \frac{a \times a}{a \times a \times a \times a \times a \times a}$, and dividing numerator and denominator by $a \times a$, the fraction becomes $\frac{1}{a \times a \times a \times a} = \frac{1}{a^4}$. Thus $\frac{a^2}{a^6} = \frac{1}{a^4}$, and $\therefore a^{-4}$ means the same as $\frac{1}{a^4}$, as we have already seen; and in general $a^{-m} = \frac{1}{a^m}$.

Case III.—When both dividend and divisor are multinomials, write them down as for long division in arithmetic, arranging their terms either both in ascending or both in descending powers of one and the same letter. Divide the *first* term of the dividend by the *first* term of the divisor. The result is the first term of the quotient. Multiply each term of the divisor by this quantity, and subtract from the dividend the product so obtained. Repeat the operation with the remainder as often as may be necessary. Thus:

Divide $a^2 + 2ab + b^2$ by $a + b$.

$$a + b)a^2 + 2ab + b^2(a + b$$
$$a^2 + ab$$
$$\overline{\qquad\qquad}$$
$$ab + b^2$$
$$ab + b^2$$
$$\overline{\qquad\qquad}$$

Here a, the first term of the divisor, goes into a^2, the first term of the dividend, a times, $\therefore a$ is the first term of the quotient. Multiplying the divisor by this quotient we get $a^2 + ab$; subtracting from the dividend we have $ab + b^2$. Repeating the operation with this remainder as dividend, we get b as the second term of the quotient; and as there is no remainder, the division is complete.

Divide $a^4 - b^4$ by $a - b$.

$$a - b)a^4 - b^4(a^3 + a^2b + ab^2 + b^3$$
$$(a - b) \times a^3 = a^4 - a^3b$$
$$\overline{\qquad\qquad}$$
$$a^3b - b^4$$
$$(a - b) \times a^2b = a^3b - a^2b^2$$
$$\overline{\qquad\qquad}$$
$$a^2b^2 - b^4$$
$$(a - b) \times ab^2 = a^2b^2 - ab^3$$
$$\overline{\qquad\qquad}$$
$$ab^3 - b^4$$
$$(a - b)b^3 = ab^3 - b^4$$
$$\overline{\qquad\qquad}$$

In this case it was not necessary to bring down $-b^4$ to form part of the first or second remainders; and, in practice generally, no term is brought down until it is required. This is exemplified in the following example:

$$1 - x)1 - x^5(1 + x + x^2 + x^3 + x^4$$
$$(1 - x) \times 1 = 1 - x$$
$$\overline{\qquad\qquad}$$
$$x$$
$$(1 - x) \times x = x - x^2$$
$$\overline{\qquad\qquad}$$
$$x^2$$
$$(1 - x) \times x^2 = x^2 - x^3$$
$$\overline{\qquad\qquad}$$
$$x^3$$
$$(1 - x) \times x^3 = x^3 - x^4$$
$$\overline{\qquad\qquad}$$
$$x^4 - x^5$$
$$(1 - x) \times x^4 = x^4 - x^5$$
$$\overline{\qquad\qquad}$$

Observe the following points of importance in all long division:

(1) Both divisor and dividend must be arranged in order according to the powers of some letter, and this order must be the same for both—*i.e.*, it must be ascending in both, or descending in both. In the first two examples above the order is descending in powers of a. In the third example the order is ascending in powers of x.

(2) Each remainder, before it can be treated as a dividend, must be arranged in the same order as the original dividend.

Examples.

Divide—

1. $16ax^3$ by $4ax$. Ans. $4x^2$.
2. $18ab^2c$ by $-9ab$. Ans. $-2bc$.
3. $-36a^2y^3$ by $-4ay^2$. Ans. $9ay$.
4. $-20x^2y^2$ by $5xy$. Ans. $-4xy$.
5. $96a^2b^3$ by $12ab$. Ans. $8ab^2$.
6. $42a^2x^2 + 3ab + 24a^2$ by $3a$. Ans. $14ax^2 + b + 8a$.
7. $90a^2x^3 - 18ax + 4a^2x - 2ax$ by $2ax$. Ans. $45ax^2 - 9 + 2a - 1$.
8. $46x^2 - 2x^2 + 8x^4$ by $2x$. Ans. $23x - x + 4x^3$.
9. $24a^3x^4y^2 - 6a^2x^3y + 9x^2y$ by $-3xy$. Ans. $-8a^3x^3y + 2a^2x^2 - 3x$.
10. $a^2x^4 - ax^3 + ax^2$ by $-ax$. Ans. $-ax^3 + x^2 - x$.
11. $-x^m - 12ax^{m-1} + 5rx^{m+1}$ by a^2x^{m-2}. Ans. $\frac{1}{3}a^{-2}x^2 - 4a^{-1}x^{\frac{5}{3}}a^{-2}rx^3$.
12. $-21x^4y - 9(a^2 - b^3)^{\frac{1}{2}}x^3y^{\frac{1}{5}} + 19(a^{-1}b^{-2})^{\frac{3}{4}}xy^{\frac{3}{5}}$ $-36xy$ by $-3x^2y^{\frac{1}{5}}$. Ans. $7x^2y^{\frac{4}{5}} + 3(a^2 - b^3)^{\frac{1}{2}}x - \frac{19}{3}(a^{-1}b^{-2})^{\frac{3}{4}}y^{\frac{4}{5}} + 12x^{-1}y^{x-\frac{1}{5}}$.
13. $a^3 - 3a^2b + 3ab^2 - b^3$ by $a - b$. Ans. $a^2 - 2ab + b^2$.
14. $a^{10} - 2a^8 + a^6$ by $a^2 - 1$. Ans. $a^8 - a^6$.
15. $x^5 - 2x^4 + x^3 + x^2 - 2x + 1$ by $x + 1$. Ans. $x^4 - 3x^3 + 4x^2 - 3x + 1$.
16. $x^{16} + 2x^{15} + x^{14}$ by $x^9 + x^8$. Ans. $x^7 + x^6$
17. $a^6 + 3a^4 + 3a^2 + 1$ by $a^2 + 1$. Ans. $a^4 + 2a^2 + 1$.
18. $x^m - y^m$ by $x - y$ to four terms. Ans. $x^{m-1} + x^{m-2}y + x^{m-3}y^2 + x^{m-4}y^3 + \text{etc.}$
19. $x^{2n+1} + y^{2n+1}$ by $x + y$ to four terms. Ans. $x^{2n} - x^{2n-1}y + x^{2n-2}y^2 - x^{2n-3}y^3 + \text{etc.}$
20. $x^{2n} - y^{2n}$ by $x + y$ to four terms. Ans. $x^{2n-1} - x^{2n-2}y + x^{2n-3}y^2 - x^{2n-4}y^3 + \text{etc.}$

21. $a^8 - 10000$ by $a^2 + 10$.
Ans. $a^6 - 10a^4 + 100a^2 - 1000$.
22. $8a^3x^3 - 27$ by $2ax - 3$.
Ans. $4a^2x^2 + 6ax + 9$.
23. $x^{15} + y^{15}$ by $x^5 + y^5$. Ans. $x^{10} - x^5y^5 + y^{10}$.
24. $a^7 + 2a^5 + a^4 + a^3 + 2a^2 + 1$ by $a^4 + 2a^2 + 1$.
Ans. $a^3 + 1$.
25. $a^4 + a^2b^2 + b^4$ by $a^2 + ab + b^2$.
Ans. $a^2 - ab + b^2$.
26. $a^{2y} - 2a^yb^y + b^{2y}$ by $a^y - b^y$ to four terms.
Ans. $a^y - b^y - \frac{b^{2y}}{a^y} - \frac{b^{3y}}{a^{2y}}$ — etc.
27. $\frac{1}{8}a^3 + \frac{3}{4}a^2x + \frac{3}{2}ax^2 + x^3$ by $\frac{1}{2}a + x$.
Ans. $\frac{1}{4}a^2 + ax + x^2$.
28. $x^2 + xy + y^2$ by $x + x^{\frac{1}{2}}y^{\frac{1}{2}} + y$.
Ans. $x - x^{\frac{1}{2}}y^{\frac{1}{2}} + y$.
29. $x^{\frac{3}{2}} + 3x^{\frac{1}{2}} + \frac{3}{x^{\frac{1}{2}}} + \frac{1}{x^{\frac{3}{2}}}$ by $x^{\frac{1}{2}} + \frac{1}{x^{\frac{1}{2}}}$.
Ans. $x + 2 + \frac{1}{x}$.
30. $x^{\frac{3}{2}} - xy^{\frac{1}{2}} + x^{\frac{1}{2}}y - y^{\frac{3}{2}}$ by $x + y$.
Ans. $x^{\frac{1}{2}} - y^{\frac{1}{2}}$.
31. $\frac{1}{a^4b^4} - \frac{1}{y^4}$ by $\frac{1}{ab} + \frac{1}{y}$.
Ans. $\frac{1}{a^3b^3} - \frac{1}{a^2b^2y} + \frac{1}{aby^2} - \frac{1}{y^3}$.
32. $a - 289$ by $a^{\frac{1}{2}} - 17$. Ans. $a^{\frac{1}{2}} + 17$.
33. $5 - 3$ by $5^{\frac{1}{3}} - 3^{\frac{1}{3}}$. Ans. $1^{\frac{2}{3}}$.
34. $a^{\frac{1}{x}} - b^{\frac{1}{x}}$ by $a^{\frac{1}{2x}} - b^{\frac{1}{2x}}$. Ans. $a^{\frac{1}{2x}} + b^{\frac{1}{2x}}$.
35. $2x + 3x^{\frac{1}{2}}y + y^2$ by $x^{\frac{1}{2}} + y$. Ans. $2x^{\frac{1}{2}} + y$.

Special Results in Multiplication.

There are certain results in multiplication which the student will find it of great importance to remember; and he is recommended to work them out for himself. The results only are given here:

The "square of $x + y$," i.e.— $(x + y)^2 = x^2 + 2xy + y$
The "square of $x - y$," i.e.— $(x - y)^2 = x^2 - 2xy + y^2$
The "cube of $x + y$," i.e.— $(x + y)^3 = x^3 + 3x^2y + 3xy^2 + y^3$
The "cube of $x - y$," i.e.— $(x - y)^3 = x^3 - 3x^2y + 3xy^2 - y^3$
$(x + y + z)^2 = x^2 + y^2 + z^2 + 2xy + 2yz + 2xz$
$(x + y + z)^3 = x^3 + y^3 + z^3 + 3x^2(y + z) + 3y^2(x + z) + 3z^2(x + y) + 6xyz$
$(x + y)(x - y) = x^2 - y^2$
$(x^2 + y^2)(x^2 - y^2) = x^4 - y^4$
$(x + y)(x^2 - xy + y^2) = x^3 + y^3$
$(x - y)(x^2 + xy + y^2) = x^3 - y^3$
$(x^2 - xy + y^2)(x^2 + xy + y^2) = x^4 + x^2y^2 + y^4$
$(x + a)(x + b) = x^2 + (a + b)x + ab$
$(x - a)(x - b) = x^2 - (a + b)x + ab$
$(x + a)(x + b)(x + c) = x^3 + x^2(a + b + c) + x(ab + ac + bc) + abc$

These results are often useful in algebra, and they often enable us to shorten the multiplication of expressions of a large number of terms. Thus, suppose we have to multiply together $a + b + c + d$ and $a + b - c - d$; $a + b + c + d$ may be written $(a + b) + (c + d)$, and $a + b - c - d$ may be written $(a + b) - (c + d)$. We see at once that $[(a + b) + (c + d)] \times [(a + b) - (c + d)]$ is in the form $(x + y)(x - y)$, and this, we know, is equal to $x^2 - y^2$. The product required then is $(a + b)^2 - (c + d)^2$, that is $(a^2 + 2ab + b^2) - (c^2 + 2cd + d = a^2 + b^2 - c^2 - d^2 + 2ab - 2cd$.

Again, since $(x + a)(x + b) = x^2 + (a + b)x + ab$, the product of $(x + 3)$ and $(x + 4)$ must be $x^2 + (3 + 4)x + (3 \times 4) = x^2 + 7x + 12$.

The student will find these results very useful when he comes to fractions, in which it is often necessary to resolve expressions into their factors.

Thus, suppose that it be necessary to find the factors of $x^2 - 12x + 35$. We know that $x^2 - (a + b)x + ab$ is the product of the factors $x - a$ and $x - b$. We wish to find a and b; and we see that these must be two numbers such that their sum is 12 and their product 35. A little consideration will show that 7 and 5 are the numbers; and on trial the student will find that $x - 7$ and $x - 5$, when multiplied together, produce $x^2 - 12x + 35$.

XLVI.

James II. (*continued*).—The Revolution.

Argyle's insurrection.

The beginning of the reign was troubled by rebellion. The Duke of Argyle, who had fled to the Continent in the last reign to save his life, after the discomfiture of the Covenanters, determined to raise an insurrection in Scotland against a government from which he expected nothing but persecution. Accordingly he made his way to the Orkneys, and thence to Cantire. But his attempt was entirely premature; his followers were quickly dispersed. He fled to Edinburgh, was taken prisoner, and executed as a traitor on the 30th of June, 1685.

Monmouth's rebellion.

Monmouth, who was an exile abroad when his father died, made a much more formidable attempt. He was exceedingly popular; his handsome person, gallant bearing, and engaging manners endeared him to the people, among whom "King Monmouth" was accounted a hero. He landed, with a few followers, at Lyme, in Dorsetshire, hoping that the west of England would rise in a mass to support him. The proclamation he put forth against his uncle, King James, was of such a violent kind that he seemed purposely to be cutting himself off from all hopes of mercy, and "setting his life upon a cast,"—but he had not the constancy and courage "to stand the hazard of the die." Many men joined him, but none of note; the peasants and scythemen who flocked to his standard had bravery and zeal enough, but they lacked discipline. Everything depended upon promptitude; but Monmouth wasted time in playing at royalty at Taunton, and receiving the homage of the ladies, while he should have been taking measures to secure the few chances of success his desperate enterprise offered. He was proclaimed king in several towns; but he had only a rabble of half-armed

peasants to oppose to the king's troops under Feversham and Churchill, when the decisive contest was fought at Sedgemoor, near Bridgewater. An attack in which it was intended to take the royal army by surprise failed, through unexpected difficulties in the ground. The raw levies of Monmouth stood long and manfully against the army of Feversham ; and it is a blot upon Monmouth's name that he fled while his followers were fighting. The rebels were defeated with great slaughter, and Monmouth himself, who had changed clothes with a countryman, was discovered hiding in a ditch in Cranbourne Chase. He was at once brought to London. A penitent letter he wrote to the king was disregarded. James indeed admitted his nephew to an interview, in which the poor duke, his arms pinioned with a silken cord, threw himself at the feet of his father's brother, and with tears implored his life. James's character, as a cold-hearted tyrant, is sufficiently shown on this occasion. He extracted from the unhappy man a declaration of

Battle of Sedgemoor, 1685.

remarkable even in those days, and that of his inhuman coadjutor, Colonel Kirke, will always be remembered with hatred ; for these men were the chief actors in that terrible "bloody assize" in the west of England, which is still a tradition of horror among the peasantry. Kirke and his cruel Tangier regiment of "lambs" practised on the unhappy captives all kinds of cruelties ; between three and four hundred persons of various ranks suffered death at this shameful assize. Especial horror was excited by the fate of an aged lady, Alice Lisle, put to death for having given shelter to two fugitives from Sedgemoor. Jeffreys and others, including some of the court ladies, received large sums of money for ransoms for such of the accused as could afford to purchase their lives. As a reward for his activity in this assize the chancellorship was bestowed upon Jeffreys.

Kirke and Jeffreys in the west.

The terror inspired by these things, and the apparent hopelessness of any attempt against his throne, induced James to take a bolder line.

MEDAL OF THE SEVEN PETITIONING BISHOPS.

illegitimacy, and endeavoured to induce him to betray his accomplices. When he found that no more was to be obtained from Monmouth, he told him his crime was unpardonable, and dismissed him to his death. An urgent prayer of the prisoner for some delay, to enable him to settle his worldly affairs, was likewise refused, and on the 15th of July, only nine days after Sedgemoor, Monmouth perished by the axe of the executioner on Tower Hill. His last sufferings were aggravated by the importunities of the bishops, who, sent to administer spiritual consolation, importuned him on the scaffold to address the soldiers standing round, on the doctrine of non-resistance and the divine right ; and by the unskilfulness of the executioner, whose heart failed him at his task.

Cruelty of the king.

Execution of Monmouth.

A cruel and ruthless vengeance was now inflicted for the late insurrection.

The name of Jeffreys, the hard-hearted and brutal chief justice, who insulted and browbeat the prisoners brought before him with a cruelty

He began to show the utmost disregard of the laws ; dismissed the parliament that showed itself disinclined to let him suspend the Test Act at his pleasure, and appointed Roman Catholic officers to commands in the army. He procured from the venal chief justice Herbert a decision that the king could dispense with the laws of England at his pleasure. He then quartered a force of 13,000 men in a camp he established at Hounslow ; and it became apparent that his scheme of government was based on the principles of Strafford's "Thorough"—despotism, supported by a standing army.

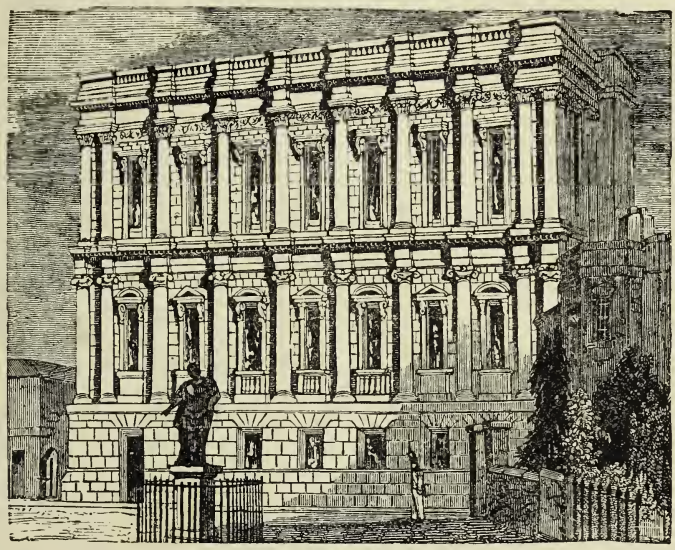
Arbitrary proceedings of the king.

The Church of England and the university of Oxford had always been distinguished by love for the monarchy and for zealous upholding of the royal prerogative ; yet with equal infatuation and ingratitude James attacked each of these institutions. A papist named Massey was appointed dean of Christchurch College, an office which

Oppressive measures against Oxford and Cambridge.

none but a Church of England man could legally hold. A Benedictine monk, Francis, was put forward for the degree of Master of Arts at Cambridge; and Anthony Farmer, another papist, was recommended as president of Magdalen College, Oxford. For refusing to elect him, the fellows of that college were deprived of their offices. The king next appointed various Catholic peers privy councillors, and proceeded to surround himself with Romanists; on the other hand dismissing divers Protestant office-holders who refused to become Papists, among others his own brother-in-law, Lord Rochester. In his arbitrary acts he held fast to the doctrine of the divine right of the king, who was above the laws, and therefore had a dispensing power, and could suspend or stop the action of a law at pleasure.

Everything pointed to the intention of the king to subvert the Protestant religion in England and establish Romanism in its stead. And accordingly the nation became angry and alarmed. The general distrust was increased by the promulgation of the first Declaration of Indulgence, in England and Scotland, in 1687. This measure, ostensibly purporting to allow Romanists and Protestant dissenters freedom of worship, was understood to be designed for the benefit of the former, to admit them to offices in spite of the Test Act; and this impression was confirmed when James appointed the Romanist Tyrconnel Viceroy of Ireland. The public reception of a nuncio of the Pope still further alarmed the community. Lord Shrewsbury, the Lord Chamberlain, declined to give the nuncio the honours of an ambassador, declaring that he feared to offend against the law. "I am above the law," replied James, and gave the chamberlain to understand that the king was to be feared as well as the law. "Your Majesty may be above the law," rejoined Shrewsbury, with admirable spirit, "but I am not; and while I obey the law, I fear nothing." And he resigned his office—an example which was followed by several of his colleagues, whom James at once replaced by Romanists.



BANQUETING HOUSE, WHITEHALL.

The bishops had been zealous adherents of the king, even while they disapproved many of his acts; and they had zealously preached the doctrine of passive obedience. But even their patience was at an end when, in April, 1688, James issued a second Declaration of Indulgence, and ordered that it should be read publicly in all churches on two successive Sundays, at morning service. Archbishop Sancroft, the primate, with six bishops, Ken, Lake, Trelawney, White, Turner, and Lloyd, presented a petition against the Declaration. The king, in anger, committed them to the Tower, till they should find bail to answer a charge of publishing a false, slanderous, and seditious libel; for so their respectfully worded memorial was designated.

Second Declaration of Indulgence, 1688.

The whole country was in a ferment. The bishops, several of whom, especially Trelawney and Ken, were very popular, were regarded as martyrs; and the celebrated "Trial of the Seven Bishops," at Westminster, was looked upon as a great conflict between the king's despotism and popular freedom. In spite of the efforts of the court to secure a conviction, the bishops were triumphantly acquitted. London was in a tumult of joy: from Westminster to the Tower one cry of triumph arose, and even the soldiers in the camp at Hounslow shouted for joy when the news reached them. This seems to have given James the first idea of his dangerous position. "Call you that nothing?" was his remark to a courtier, who affected to make light of the circumstance that the soldiers were jubilant. But he added, "So much the worse for them,"—for he was determined to continue as he had begun.

The birth of a prince of Wales to James and Mary of Modena (his four sons by Anne Hyde had all died young) pointed to a succession of Romanist kings in England, and the demonstration on the acquittal of the bishops showed the state of popular feeling in the country. Accordingly an invitation was secretly dispatched by some of the leading

Invitation to William of Orange.

men in England to William of Orange, the son-in-law of James, who accordingly came to England with an army of 14,000 men, and landed at Torbay, in Devonshire. James at first made light of the danger, probably deeming the new invasion could be put down like that of Monmouth. But his partisans and favourites, including Churchill, Lord Marlborough, his son-in-law George, Prince of Denmark, and his own daughter Anne, deserted him; and he lost courage and resolved on flight. The queen and the infant prince of Wales were sent away to France. The king himself endeavoured to follow, but was stopped at Sheerness, where he intended to embark, and brought back to London. William, meanwhile, being joined by men of position and influence, advanced to the capital; and James, giving up his cause for lost, made a second attempt at flight, which was successful. He left England never to return, and threw himself on the kindness of Louis XIV. of France, who received him with royal hospitality.

Flight of the king.

The flight of James was considered as an abdication; and now the question arose under what conditions the crown of England should be offered to William and his consort Mary, the elder daughter of James. The provisional government, at the head of which stood Lord Halifax, the chief of the moderate party called Trimmers, negociated with the Prince of Orange. A convention of Lords and Commons met in January, 1689, declared the throne vacant, and that the welfare of England could not be secured under a popish ruler. At length it was decided that William and Mary should rule, on their subscribing to the celebrated "Declaration of Rights," a document which has been justly designated as the second great charter of English liberty. This measure disposed summarily of the divine right "pretensions" by declaring that the dispensing power claimed by James was illegal; that an English king had no right to alter, abolish, or suspend the action of the laws without the consent of parliament; cruel and unusual punishments and excessive fines were declared to be against the spirit of English government; the right of the subjects to petition the king was secured, with the frequent meeting and the free elections of parliaments; and the consort of the king of England was, like himself, to be a Protestant. In full faith that its principles would be accepted and maintained by William and Mary, this famous measure ended by declaring the Prince and Princess of Orange King and Queen of England. It was presented on the 13th February, 1689, to William and Mary by the two Houses in the banqueting-room at Whitehall.

Convention.

The Declaration of Rights, 1689.

Its presentation.

Thus, after the revolution of 1688, William III. and Mary II. mounted the throne as constitutional monarchs, ruling with the parliament; and since that time the royal prerogative has always been subject to strict parliamentary and constitutional limitation.

Accession of William III. and Mary II.

XLVII.

Syntax of Subjunctive Mood (*continued*).

Vocabulary.

The following verbs have a middle force, like the Greek middle voice:—

pignerari	= take to (oneself) as a pledge; pignerare = to give as a pledge
moveri	= to move (oneself); movere = to move (something else)
verti	= to turn (oneself); vertere = to turn something else
arbitror	= I decide for myself
censeor	= I put forward my own reason; censere = to return as one's assessment.
dignor	= I think (myself) worthy
nidulor	= I build my nest
commendari	= to recommend oneself
cogor	= I feel myself driven or obliged
congregari	= to assemble themselves
contrahi	= to contract itself
delectari	= to delight oneself
effundi	= to pour out oneself
diffundi	= to spend itself
lavari	= to wash or bathe oneself
mutari	= to change itself
porrigi	= to reach oneself
tondeor	= I get myself shaved

Exercises.

Translate into English:—

Dic mihi, quare movear. Nititur ut vertatur. Id te præsentem decet, quod pignereris. Arbitratum, quòd tecum sit. Non dignor me tali honore, ut tuam vitam agem. Quid prohibitum est, quin lavaretur. Non porrigor, ut tibi placeam. Censebatur Romæ, quùm Athenis habitaverit. Quid mutaris, ut luerum vili possideas. Quid tu coactus est, ut eos mores gesseris? Rogo quid agatis. Rogavit quid agerent. Rogavit quid egissent. Roga tu quid acturi sint. Nescio quare me ex civitate expuleritis. Cognoscere non potuit quantæ essent hostium copiæ. Speculabimur quot homines in urbem incant et quot exeant. Dic mihi, Catilina, cur patriam prodere volueris. Dic mihi, Balbe, ubi corpus abjeceris. Solon ex oraculo quæsivit quis omnium Græcorum sapientissimus esset. Quid te juvat, homo improbissime, ut miseris succursurus nihil unquam natus fuisses? Et tu et exercitus Romanus ad urbem cito veniunt, quò facilius ejus mœnia diruatis. Nostri animi moventur, ut eos pauperum misereat. Questus sum iterum atque iterum, quid vos nihil nisi estis ut potui succurratis. Subdifficilis est quæstio num unquam novi amici sint veteribus anteponendi? Rogavit nonne hæc improba et infamia essent? Rogabo num credat omnia casu facta esse? Quæsivit ex oraculo Crœsus, utrum ipse an Cyrus superaturus esset. Sæpenumero quærebant antiqui philosophi mortalisne esset animus an immortalis. Num dubium

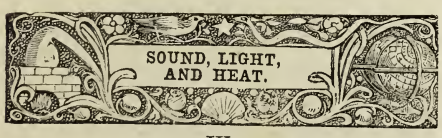
est casune an consilio factus sit mundus? Plane incertum est vicerintne hostes an victi sint.

Translate into Latin :—

They pray that I will not forsake them in these sudden miseries. I complain that they move themselves (middle verb, with *caprice*), and against their own interest. Inquire of (*ex*) him whether he knows these things. It is doubtful whether these things are true. It is uncertain whether (*utrum* or *ne*) he is a good man or a wicked (one). It is doubtful whether he deserve praise (*laudemne*) or blame. He asked whether the dead felt cold and hunger. I know not whether you are sleeping or waking. I doubt whether he will return (*subj. pres.*) immediately. He asked whether the city was very strongly fortified. This I ask you, whether you were or not (*nonne*) that (*ille*) night in the house of M. Læca? Do you doubt whether it behoves a good citizen to side with his country in time of danger? Tell me, if these things are true or not. It is uncertain whether the enemy will move itself. He knows well what he is about, though he knows not what is for his interest (*expedit*). They will hear all that you are doing. I had learnt from the enemy what you were doing, and now I see it all with my own eyes. I shall hear soon, I hope, what you are going to do, and what pledge you will take upon yourself, and at what rate you value yourself. He inquires what is the duty of a philosopher towards his fellow-citizens and his own country—a circumstance which seems to delight him very much.

Questions for Self-Examination.

Write out the laws of sequence of tenses in the subjunctive and indicative moods. What are the primary and what the historical tenses? Give examples in Latin. What do you mean by a middle verb in Latin? and with what do you compare the Latin middle verbs in Greek? Learn off and write out the vocabulary here given of middle verbs.



IV.

SOUND (*continued*).

BY such means as those mentioned in the preceding article, numerous experiments have been conducted to ascertain the relation which exists between the pitch of a note and the number of vibrations producing it, and as the result of these investigations it has been ascertained that the pitch of a note varies directly as the number of vibrations: increase the number of vibrations, and you raise the pitch; decrease the rate of vibration, and you lower the pitch. Every one is familiar with the ordinary meaning of the term "octave," as applied to the pitch of a note. When we say that one note is the octave of another, we mean that it has twice as high a pitch, and this is found to precisely correspond with the acoustical meaning of an octave. When we have two notes, one of which is produced by twice as many vibrations as the other, we find that they are separated by exactly an octave. For example, the middle C of the piano is produced by 256 vibrations per second, its octave by 512, and its double octave by 1024 vibrations per second. Pitch is therefore directly proportional to the number of vibrations.

Relation between pitch and the rate of vibration.

Knowing the number of vibrations produced by a sounding body, we may easily determine the length of the waves of sound it emits. If, for instance, the temperature of the air be the freezing point of water, we know the velocity of sound to be 1090 feet per second; consequently, if it were possible to have only one vibration per second, the wave length of the note produced would obviously be 1090 feet. In our imaginary experiment, however, we found the number of vibrations per second produced by the tuning fork to be 384—that is to say, 384 sound-waves were generated by it in a second. It follows, therefore, that each wave could only be the $\frac{1}{384}$th of 1090 feet in length, or about 2·8 feet. In order to find the wave-length of a given note we have only to divide the velocity of sound in air of the given temperature by the number of vibrations per second, and the quotient will be the answer. Conversely, to find the number of vibrations, having given the wave-length, we must divide the velocity of sound by that wave-length.

Length of sound-waves.

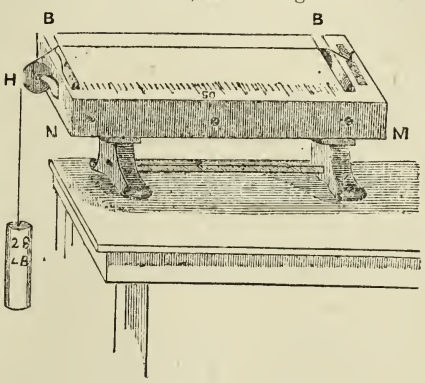


FIG. 15.—THE MONOCHORD.

The lowest sound which can be appreciated by the human ear is that produced by 16 vibrations per second, while the highest is one produced by 38,000 vibrations per second. No single ear possesses such an extensive range (nearly 11 octaves), but this result embraces the highest and lowest notes respectively capable of being appreciated by *any* ear. In music only about 7 octaves are usually employed, comprising sounds with vibrations ranging between 40 and 4,000 per second.

Limits of the human ear.

We have seen that the pitch of a note depends upon the number of sound-waves which enter the ear in a second of time; if

therefore, we could in any way crowd into the car a greater number of vibrations than the sounding body is producing, the pitch of the sound would be raised; and *vice versâ*. This, under some conditions, is really the case; and a familiar instance is the rising in the pitch of a whistle as an express train approaches a station, succeeded by a fall of pitch as the train recedes.

Variations in the pitch of a sound emitted by a moving body.

If a person be standing at a station as an express train approaches it, it is obvious that more vibrations from the whistle will enter his ear in a given time than if the train were standing still, while, as the train rapidly recedes, the number of vibrations perceived will be less; hence in the first instance the pitch of the whistle will be higher, and in the second case lower, than if the train were at rest. A familiar illustration will perhaps make this more plain. Suppose that a person wishes to take an omnibus, and accordingly stands at a spot where the omnibuses pass regularly once in every five minutes. Suppose, further, that one or two omnibuses coming up full, he begins to walk towards the place from which the omnibuses start: it is obvious he will meet more than one omnibus in five minutes, but if, on the other hand, he should walk towards the place to which the omnibuses are going, there will be a longer interval than five minutes between the time of each omnibus overtaking him. In just the same way the sound-waves from the whistle of the locomotive are shortened as the train approaches, and lengthened as the train recedes from the station, and so in the first instance more sound-waves enter the ear in a second, in the latter fewer are perceived.

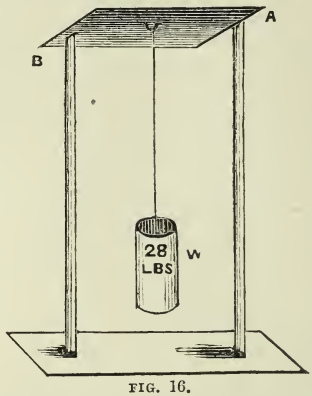


FIG. 16.

Pursuing our study of musical sounds, we must next turn our attention to a consideration of the various means adopted for the production of such sounds, and the laws by which they are governed. A very large and important class of musical instruments are formed in various ways from strings capable of vibrating *transversely*, that is, at right angles to their length; and we will now proceed to examine into the manner in which such strings can be made to vibrate, and the connection between their vibrations and the sounds they produce.

Transverse vibrations of strings.

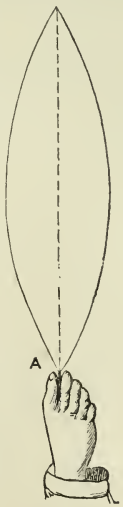


FIG. 17.

In order to investigate the laws of strings, the apparatus shown in fig. 15 will be found extremely useful, and as it can easily be constructed even by the least ingenious, we hope that our readers will make one for themselves, and prove by actual experiment the truth of the statements we are about to lay before them. M N is a hollow box about four feet long, upon which two wooden bridges, B, B, are firmly glued; behind B is an iron peg, while at H a small brass wheel is fastened. Those of our readers who make a monochord for themselves will find a good piece of well-seasoned inch deal answer very well instead of the wooden box, and it will be advantageous to make the instrument for two wires instead of one. If this be done, there should be two iron pegs side by side at one end, and at the other end a wheel on one side, and a peg which can be tightened or loosened at pleasure on the other. From this peg to the corresponding one at the other end, a wire may be permanently fastened, while a second wire may be arranged side by side with it, stretched by a weight, as shown in the figure. The stand is not indispensable, though some kind of support to raise the board slightly above the table is a great improvement. Upon the space between the bridges a paper scale divided into any number of equal parts (100 is the most convenient number), is pasted. When, as in the figure, a wire is stretched by a weight upon the monochord, it will, upon being struck or pulled, give out a musical sound.

The monochord.

If instead of stretching the wire upon some larger body, such as the frame of the monochord, it be suspended, as in fig. 16, from an iron bar, and stretched as before by a weight, although the wire may readily be made to vibrate upon being plucked no sound will be produced. The explanation of this curious fact is connected with that already given, to account for the feebleness of sounds in hydrogen as compared with those in air. The string of itself does not present to the air a sufficiently large vibratory surface, and is therefore unable to mould the air into sonorous waves, the aerial particles merely slipping on one side when struck. When, however, the string is in connection with some larger body, as for instance the board or box of the monochord, to which it can impart its vibrations, the vibrating surface is now sufficiently large to prevent the air particles slipping on one side, and compels them to form into acoustic waves. Here we see the use of sound-boards in such instruments as the piano, violin, harp, etc., and it is of course of the highest importance that the makers of these instruments should see that the sound-boards are made of such materials as will most readily and efficiently accept the vibrations of the strings.

Sound boards.

By the aid of the monochord the following laws have been shown to govern the vibrations of strings, when vibrating *transversely*: as we

Laws of vibrating strings.

shall subsequently see, these laws do not apply to the *longitudinal* vibrations of strings.

1. *The number of vibrations is inversely proportional to the length of the string.*

2. *The number of vibrations is inversely proportional to the diameter or thickness of the string.*

3. *The number of vibrations is directly proportional to the square root of the stretching force.*

4. *The number of vibrations is inversely proportional to the square root of the density of the string.*

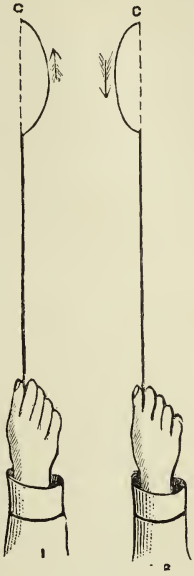


FIG. 18.

Each of the above laws may be easily verified by the reader for himself with his monochord. If the permanent string of the monochord be plucked it gives out its lowest or *fundamental* note. Now place exactly beneath the middle point of the string, as indicated by the graduated scale, a small bridge, or a piece of stiff card, so as to make that point a fixed one; upon plucking either half of the string the note emitted is exactly an octave of the fundamental. If the bridge be placed at one-fourth the length of the string from one end, and the smaller division be plucked, the note emitted is the double octave of the fundamental. The number of vibrations is thus shown to be inversely proportional to the length of the string, which is our first law.

To prove the second law take two pieces of wire of the same material, but one piece twice as thick as the other; it will be found that the thinner wire will give out a note which is the octave of that emitted by the thicker wire.

The third law may be proved by taking a wire and stretching it upon the monochord as in fig. 15. If weights be employed such as are represented by the numbers 7, 28, 63, 112, it will be found that if the string is stretched by these weights in succession the notes produced will be in the proportions 1, 2, 3, 4, thus showing that the number of vibrations of a stretched string are directly proportional to the square root of the stretching force.

Finally, the fourth law may be demonstrated by taking wires of different materials and submitting them to the same stretching force; it will be found that the notes they yield are inversely proportional to the square root of their respective specific gravities (that is of their density). Thus if the specific gravities of two wires are as 1 to 4, the former will yield a note which will be the octave of that from the atter.

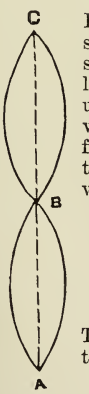


FIG. 19.

The consideration of these facts is not only of interest to students of science, but to performers on stringed instruments. It is to be regretted, however, that players are, as a rule, prone to ignore those physical laws on which their performances depend.

IV.

Rhyming Chroniclers (*continued*).—Metrical Romances.

Warton, in his *History of Early English Poetry*, gives a curious anonymous ballad satirically describing the discomfiture of a French army sent by Philip the Fair against the Flemings, in 1301. The verses have considerable spirit, and are thoroughly English in character. The poem begins:— **Early satirical ballad.**

"Lusteneth, lordinges, both zonge and olde,
Of the Freynshe men that were so proude ante bolde
How the Flemmyshe men bohten hem ante solde,
Upon a Wednesday,
"Betere hem were at home in huere londe,
Than force seche Flemishe bi the sea stronde
Whare rouch moni Frensh wyf wryngeth hire honde,
And syngeth wel away," etc.

[Listen, lords, both young and old,
Of the Frenchmen that were so proud and bold,
How the Flemish men bought them and sold,
Upon a Wednesday.
Better they were at home in their land,
Than to fight such Flemish by the sea strand,
Where through many a French wife wringeth her hand,
And singeth Well away, etc.]

Robert Manning, or Robert de-Brunne (of Bourne in Lincolnshire), left several works of importance. Besides versifying Piers Langtoft's *Chronicle*, he translated Bishop Grosteste's *Manuel des Péchés*, under the title *A Handlyng of Sinne*. He writes in the eight-syllable line, which is far better adapted than the Alexandrine to the English language. Of this the author was doubtless aware, for he tells us:—

"I wrote
In symple speeche as I couthe,
That is lightest in manne's mouthe,
I mad (made) nought for no disours*
Ne for no siggers nor harpours,
But for the luf of symple menn
That strange Inglis cann not ken."

The work consists of stories illustrating the seven deadly sins.

Richard Rolle, the Hermit of Hampole, translated the Psalms into English prose, and moreover translated "for the unlettered men of Engelonde," who can only understand English, a long poem, *The Prikke of Conscience*. Thus the English had their authors, who wrote for them in a tongue akin to the old Anglo-Saxon; and in spite of the Norman domination, dialects of English differing among **Richard Rolle the Hermit of Hampole.**

* *Discurs*, tale-tellers.

themselves, and in many instances rude and uncouth enough, kept the old language alive. We have a specimen of the Kentish Semi-Saxon of 1340, in the shape of a book written by a Saxon monk of St. Austin's, Canterbury. The words are homely and simple, and form a good specimen of the English spoken by the Kentish men in the fourteenth century. The author tells us:—

"Nou ich wille that ye ywit how hitt is ywent
That this boc is ywrite mid Engliss of Kent.
This boc is ymade vor lewede men,
Vor Vader and vor Moder, and vor other Ken,
Ham vor to berze vram alle manyere zen," etc.

[Now I will that ye know (wis) how it is went (has happened)
That this book is written with English of Kent.
This book is made for lay (unclerical or unlettered) men,
For father and for mother, and for other kin,
Them for to purge from all manner of sin.]

Another short specimen of the English of the middle of the fourteenth century may be useful here. It is from ROBERT DE BRUNNE'S (MANNING'S) translation of Piers de Langtoft's *French Chronicle* (about 1340):—

Langtoft's Chronicle.

"Edward did smyte rounde peny, halfpeny, ferthing,
The croise passed the bounde of alle thorghout the ryng,
The kyng's side salle be the hede, and his name writen,
The croyce side, what citè it was incoyned and smyten;
A thousand and two hundred and fourscore yeres mo,
O this monè men wondred first when it gan go."

Metrical Romances.

The early English language is now illustrated by a number of metrical romances. The travelling minstrel and joculator were now recognized visitors, and not, indeed, unwelcome guests, in the baronial castle; and the Crusades, and other great military enterprises from the twelfth to the fourteenth century, naturally spread a spirit of adventure and warlike achievement, which showed itself in the literary productions of the period. A story like that of Alexander the Great, of King Arthur, of Rollo the first duke of Normandy, or of Charlemagne the great Frankish king, was treated in metrical fashion; and the narrative was so mixed with fable, that even where the life of a real hero was the subject, the details were entirely imaginative. The *Castel of Love*, by ROBERT GROSTHEAD, or GROSSETETE, Bishop of Lincoln, may be taken as an instance of the metrical romance. Another work of this kind celebrates the deeds of the Lion-hearted Richard in Palestine. *Guy, Earl of Warwick*, is said to have been written by a Franciscan friar, WALTER of Exeter, about A.D. 1292. *Amys and Amelion*, MERLIN'S *Prophecies*, TURPIN'S *Charlemagne*, and *The Destruction of Troy*, are others, *Colbrand the Giant*, "that same mighty man" who, according to the old fable, was conquered by Sir Guy in a meadow outside the walls of Winchester, likewise had his adventures celebrated in a metrical romance. Before the beginning of Edward the Second's reign minstrels had become regular members of the households of our nobility; they were clothed and paid with great liberality, and even admitted, in virtue of their office, to unusual privileges. "At the magnificent marriage of the Countess of Holland, daughter of Edward I., every king minstrel received forty shillings." *The Squire of Low Degree*, *Impomedon*, *King Robert of Sicily*, *Sir Degore*, and a host of others, swell the catalogue of this kind of literature, which has been treated fully and learnedly in Ellis's *Metrical Romances*, in Percy's *Reliques*, and by Warton, Isaac D'Israeli, and others.

Metrical romances.

The minstrels and their lays.

In *The King of Tars* we have a story of a war between a Christian and a Paynim ruler. The title runs thus: "Her bigenneth of the Kyng of Tars, and of the Soudan of Dammius, how the Soudan of Dammius was cristened thoen Godis gras." The romance tells how the Sultan of Damascus falls in love with the daughter of the King of Tarsus. He asks her hand of her father in marriage, and is refused; whereupon a war ensues, wherein the Sultan makes a great slaughter of the Christians; and the King of Tars sits in his hall and makes great dole or lamentation. His daughter, against her father's wish and command, betakes herself to the Sultan, whom she offers to marry, to bring about a peace. The Sultan receives her joyfully, the marriage takes place, and ultimately, like many a wife of a rude Saxon or Frankish chief of the bygone times, the fair princess persuades her husband to become a Christian, and to destroy his Saracen idols. Like Clovis, the proud Sicambrian, he is enjoined "to burn what he had adored, and to adore what he had burned."

The King of Tars.

The following lines give some particulars of the fight between the Saracens and the Christians, in which the latter were worsted:—

"The steorne Sarazyns in that fihte,
Slowe vr (slew our) cristen men doun rihte, [mad).
Thei fouhte as heo weore woode (as if they were
The Souldan's oste (host) in that stounde
Ffeolde the cristene to the grounde,
Mony a freoly foode;
The Sarazyns, withouten fayle,
The cristens culd (killed) in that battayle,
Nas non that hem (them) withstoode.
When the king of Taars saw the sight
Wood he was for wrath a pliht;
In honde he hent (in hand he took) a spere,
And to the Soudan he rode ful riht,
With a dunt (dint) of much miht,
Adoun he gon him bere;
The Souldan neigh (nigh) he hadde islawe (slain),
But thritti thousant of hethen lawe
Commen him for to were (guard);
And brougten him agen uppon his stede,
And holpe him wel in that nede,
That no mon miht him dere (hurt).
When he was brouht uppon his stede,
He sprong as sparkle doth of glede (coal),
Ffor wrath and for envye;
All that he hotte he made them blede,
He ferde as he wolde a wede (firebrand).
Mahoun help, he gan crye.
Mony an helm ther was unweved,
And mony a bacinet (helmet cleft) to cleved
And saddles mony emptye;
Men miht se uppon the felde
Moni a kniht ded under schelde,
Of the cristen cumpagnie.
Whon the kyng of Taars saug hem (saw him) so ryde,
No longer than he nold abyde,
Bote fleyh (but fled) to his owne cite:
The Sarazyns, that ilke tyde,
Sloug (slew) a doun bi vche (each) syde
Vr cristene folk so fre.

The Sarazyns that tyme, sauns fayle,
Slowe vre cristene in battayle,
That reuthe (pity) it was to se;
And on the morwe (morning) for heore (their) sake
Truwes (truce) thei gunne for to gidere (together) take,
A moneth and dayes thre."

We have now to notice the first prose work of importance in the English language—the journeyings of that indefatigable traveller, the successor of Marco Polo, and mediæval representative of the Humboldts, Livingstones, and Stanleys of our own times, the worthy SIR JOHN MANDEVILLE. This old traveller was born at St. Albans in 1300; and in his own words, "on the day of St. Michael, in the year of our Lord 1322, passed the sea, and went the way to Hierusalem, and to behold the mervayles of Inde." After thirty-four years of travel, the pilgrim eame home; not, as he tells us, from his own inclination, but driven by infirmity and failing health. Then he wrote an account of his travels, first in Latin, then in French, and finally in English, "that every man of my nation may understand it," he says. A writer well observes regarding this arrangement, "We see the progressive estimation of the languages by this curious statement which Mandeville himself has given. The author first secured the existence of his work in a language familiar to the whole European world (the Latin); the French was addressed to the politer circles of society; and the last language the author cared about was the vernaeular idiom, which, at that time the least regarded, required all the patriotism of the writer in this devotion of his pen." SIR JOHN MANDEVILLE gives us his experiences with great minuteness of description, and with all the simple faith and unquestioning belief that marked those primitive times. The worthy traveller has evidently no intention of decceiving his readers or hearers; he simply repeats, with undoubting credence, all the wonderful stories he hears during his peregrinations; and he accepts as true all that previous writers have recorded. "The trees of the sun and of the moon are well known to have spoken to King Alesaundre (Alexander) and warned him of his death," says Mandeville, gravely, for he had *read* the fact, and it never occurs to him to doubt it. He repeats the wonderful stories of Ctesias concerning India; but generally secures his own veracity by a cautious "men sayn." He deseribes the locality of Paradise, but confesses, "I was not there"—but he has *heard say* that it is on the highest circle of the earth. That he sometimes mixed up what he had seen with what he had heard is doubtless true; and that his imagination sometimes played him strange tricks, as in "the valley perilous," where he professed to behold the head of the enemy of mankind, "with great flaming eyes," is probable also; but that he *fancied* he saw all this we have no reason to doubt.

Sir John Mandeville, the traveller.

Credulity of Mandeville.

An Elegy on the death of Edward the First, in 1307, shows a great advance on former poetry. The stanza has a regular form, and the prefixes and affixes have generally fallen away. The following verses will give an idea of the poem:—

"Al England ahte forte (ought for to) knowe:
Of whom that song ys that ysynge,
Of Edward kynge that ys so bolde,
Gent al this world is nome con springe:
Trewest mon of al thinge.
Ant in werre ware and wise;
For hym we ahte (ought) our honden (hands) wrynge,
Of christendome he bare the pris.
"Byfore that oure kynge was ded
He speke as mon that was in care:
'Clerkes, knyhts, barrons,' he sed,
'Ycharge ou (you) by oure sware (your oath)
That ye be to Englond trewe;
Y deze (I die), y ne may lyven (live) na more;
Helpeth mi sone, and crowneth him newe,
For he is nest to buen y-core (next to be chosen)."

In LAWRENCE MINOT we have a writer of lays or ballads on the great events of his time, relating to Edward the Third's wars in France and Scotland. One begins, "Lithes, and I sall tell you tyll, The bataile of Halidon Hyll"; (Listen, and I will tell you, etc.); another, "Herkins (hearken) how King Edward lay, With his men before Tournay"; and a third tells how "Edward oure eomely king, In Brabant has hys wonyng (dwelling)."

Lawrence Minot's lays.

And now, in the reign of Edward III., the time had come when the English was definitely to supersede the Norman-French, and to become the recognized language of the higher classes as well as of the people. English is taught in the grammar schools: "Now," says TREVISA, "the yere of our Lord 1385, in all the grammere scoles of Engelond children leaveth Frensche and construeth and lerneth in Englische." It is found expedient to translate books into English; national enterprises and common dangers draw the various elasses closer together, so that invidious distinctions of race are lost; and in 1362 comes the very important decision of the king that law pleadings are heneeforth to be in English. Then also the sturdy common sense of the English people, aided perhaps by a latent disposition for satire, calls forth a series of protests against the glaring incongruity between the lives and the profession of many members of the clerical order. Wickliffe and his followers become an intelleetual power in the land; the Bible is translated into English, and becomes a new method of perpetuating the language. At a somewhat later period, Henry V., noting, in a letter to one of the City Companies, how "the English tongue hath been in modern times honourably enlarged and adorned," desires that it should be used instead of the Latin, in the transactions of civil life. Parliamentary proceedings are noted down in the mother-tongue, and both Henry V. and his father left their wills in English.

Triumph of the English tongue.

The English language used by the kings.

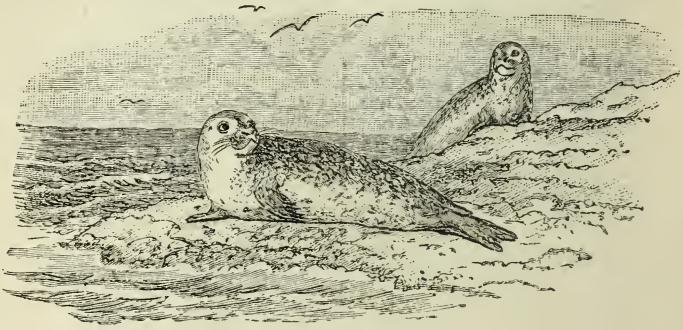
That this victory of the English tongue was very gradual, is shown by the frequent occurrence of two or even three languages in the same document. Thus a petition of an Irish chief, a prisoner, may be noticed: the chieftain writes in French, the royal answer is written across it in English, and the order of the council is in Latin.

ZOOLOGY.

XX.

The Weasel Family (*continued*).

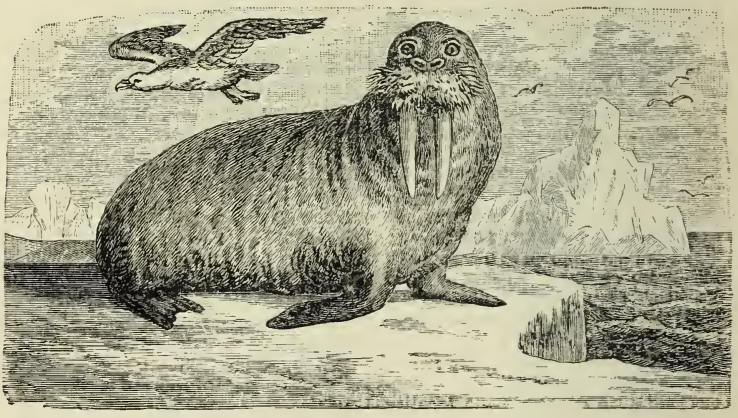
The Skunks need no trumpeter to blazon forth their name. They are "famous in a bad sense" wherever disgusting stenches are hated. When an animal can eject a liquid three or four yards, and when the odour clings for months to anything touched by the fluid, it will be admitted that the animal thus gifted is well protected. The glands under the tail from which this fluid is ejected are really similar to those possessed by all the family, but in course of time the odour appears to have become so effectual a defence to the skunks that the ferocity of the



SEAL.

and this can be got rid of successfully by careful treatment. It is black, with certain white stripes on the forehead, neck, and back, the pattern of which varies considerably. Skunks are common in most portions of temperate North America, and very abundant in some districts. There is also a species of skunk in South America and Mexico. Skunks seek their food largely by night, and they devour smaller prey of the same kind as the martens and weasels; insects, birds' eggs, frogs, and mice being included in their dietary.

To learn how to dig, go to the Badger, and you will find an animal which can hide itself in the ground in a minute, so powerful are the short legs and shoulders; the fore feet are used for actual excavating, the hinder for throwing the earth out of the hole. This power, combined with shyness, has made them really little known by man. The body of the badger is very stoutly built, and heavy for its bulk; its body is



FULMAR PETREL. WALRUS.

group seems to be replaced in them by shyness and timidity. In outward form they resemble badgers rather than weasels; they walk on the soles of their feet; they have some considerable digging power; the legs are short and body low. They are not climbers or swimmers. Their teeth are thirty-four in some species, thirty-two in others; but there is considerable variation in the teeth and in the skeleton generally. They have a very bushy long tail, with coarse hairs, sometimes seven or eight inches long. The fur would be very valuable but for the odour,

Skunk fur.

over two feet long, and its tail over seven inches. The habits of badgers, so far as observed, are not repulsive: they are capable of play, are fond of each other, and may even be partially domesticated. Their diet is very varied: partly fruit and roots, partly insects and honey, partly small vertebrates. In some American localities where the soil is suitable for burrowing they are extremely numerous, so that their holes constitute dangerous pitfalls for the traveller. Their strength renders them very secure against attack when in their holes, and they can maintain a stout defence against wolves

and foxes. The fighting qualities of the creature led to the cruel sport of badger-baiting, in which the animal was truly beset on all sides and "badgered," yet often came off conqueror. The fur of the badger is of value, and its long hairs are much employed in the manufacture of shaving brushes and various artists' materials. The colour is a mixture of black, gray, and white, with gray predominant, so that the expression "as gray as a badger" is very familiar. The Old World forms are divided into three genera—two Asiatic, one European and British. In America there are two species—one in North America, the other in Mexico.

Fighting qualities.

"As gray as a badger."

The Otters form a concluding group of land carnivora, which are plainly related to the weasels and badgers, but yet exhibit many modifications allying them to the seals, in correspondence with their aquatic mode of life. Their fur is close and thick, their body almost cylindrical, with no marked neck, the head rounded, the tail long and flattened, the feet broad and webbed. The teeth are eighteen above and eighteen below, and their surfaces partially lose the sharp cutting character, the grinders of the sea-otter having rounded knobs. The small size of the ears also corresponds with the aquatic habit. The fur of several species of otters is so valuable, especially the sea-otters, that they will very probably become extinct. They are the largest animals of this group, extending from four to five feet in total length. They are most expert swimmers, and catch and kill large quantities of fish.

Otters.

An interesting habit of otters is that of sliding down snow-ridges rapidly in company, this being repeated many times in succession for amusement. The gambols of otters in the water are most varied and energetic. They live in burrows in the banks of rivers, not very complex, any convenient hollow being used, and lined with grass. Bell says: "It swims and dives with great readiness, and with peculiar ease and elegance of movement. It swims in nearly a horizontal position, and dives instantaneously after the fish that may glide beneath it, or pursues it under water; and when the prey is secured brings it on shore to its retreat to feed." Thomas Edward says the longest time the otter naturally remains under water is three to four minutes, the usual time being two to three minutes.

Playful habits.

Otters have been often tamed, sometimes answering perfectly to a whistle; when taken as puppies and accustomed to a milk diet, they have been trained to catch fish and bring them home untouched. There are species of otters on all the continents except Australia. Otter-hunting is a sport of considerable antiquity in England, special otter-hounds being trained to beat the game out of their holes. They take to the water, dive, and come up at a distance. When seized by the dogs, they endeavour to plunge and drown the animals that have fastened on them.

Otter-hunting.

The sea-otter of Kamtschatka, Alaska, and the North Pacific is most highly specialised for seafaring. The paws are strikingly modified as flippers, differing from the seals in having the inner digits longest. The animal is more massive than ordinary otters, and has a shorter, stronger tail. The colour is generally brown, with a number of silvery or lighter hairs. The male is much the handsomer. The grinders are more like peb-

Sea-otters

SEA-LIONS. ALBATROSS. GOLDEN PENGUIN.

bles than cutting teeth. Exceedingly ingenious methods of capture are practised in the Aleutian Islands and Alaska, where their numbers are rapidly diminishing.

The sea-otter mother sleeps in the water on her back, with her young clasped between her fore-paws. Their food is almost entirely of shell-fish, which they break by striking the shells together held in each fore-paw, sucking out the contents when fractured. They are not polygamous. Their flesh is unpalatable. They are very playful, amusing themselves with tossing pieces of seaweed about, playing with the young, etc. Their hearing and smell are very acute; they are driven away by fires on shore or by the traces of man's footsteps, and thus hunting them requires the use of many devices which we cannot particularise.

Habits.

MECHANICAL OCCUPATIONS.

II.

Let us now take a glance at apprenticeship. An apprentice (from the French verb *apprendre*, to learn—hence a learner) is a person bound to another person's service for a term of years, and receiving therefor instruction in his master's business, and perhaps wages. Apprenticeship had its origin in the system of associated trades which prevailed in almost all parts of Europe in the Middle Ages. Those only who were "free" of a trade were allowed to exercise it; and the usual, if not indispensable, way of acquiring this freedom was through an apprenticeship to a member of the body for a time, under regulations varying in different towns, and in different trades in the same town. In some instances the rules designed to limit the numbers of the fraternity were so strict as to prohibit the master from taking any apprentice but his own son. Sometimes a premium is paid by the apprentice, or his parents or guardians on his behalf, to the master. By a provision of 5 Eliz., c. 4, which remained in force until a recent period, it was generally required that every person exercising a trade in England should have previously served as apprentice to it for seven years; but of late years that provision has been abolished, with a saving of the byelaws in London and other corporations. By the Municipal Act, 5 and 6 Will., c. 76, s. 14 (which does not, however, extend to London), all such customs and byelaws as had the effect of prohibiting trades and occupations to persons who had not served as apprentices were done away. In France the apprentice, after having served in that capacity from three to eight or ten years, served as a journeyman, called the *compagnon* of his master, a number of years more, after which he was entitled to admission as a master into the *communauté* or *corps de marchands* of his trade, and gave in his *chef-d'œuvre*. This *chef-d'œuvre*, which he was required to deliver to the wardens of his company, showed him to be a proficient in his art. Sons of merchants living with their fathers until they were seventeen years old were entitled to the privileges of those who had served their apprenticeship. These companies were abolished at the Revolution, but the contract of apprenticeship, although no longer imperative, is still frequently entered into in France, and there are statutes regulating rights and duties of the parties to it. In Germany, where the system exists at the present day in a more or less modified and legally-limited form, the term of apprenticeship (*Lehrjahre*) is generally about seven years, or sometimes less. The apprentice, after serving for the prescribed time, becomes a *Gesell*, like the French *compagnon*, and is entitled to receive from the guild a general letter of recommendation, armed with which he commences his travels. Being recognized and employed by his brethren of the same craft, he works his way from town to town, and on returning with certificates of good conduct during his *Wanderjahre* (travel-years), is entitled to become a master. In Italy the contract for apprenticeship resembled that in use in England. In Scotland and Ireland the regulations regarding it were never rigorous, and those existing in the latter country were early superseded by the English laws designed to encourage emigration. In the twelfth century guilds were formed in this country; and shortly after, no doubt, apprenticeships came into vogue, although there is no notice of them in the statutes until the year 1388.

The law upon the subject of apprentices has been revised and settled in the Masters and Servants Act of 1867 (30 & 31 Victoria, c. 141). A mere agreement does not constitute an apprenticeship; there must be regular indentures, formally executed. In the performance of the contract a reasonable and equitable view is taken of the relative position of the parties. The master is not bound to the literal and uniform instruction of the apprentice by himself personally, but under his own superintendence and by his own directions he may avail himself of the assistance of journeymen or other persons serving in his place of business, or even of other apprentices—the object of the agreement being that the apprentice shall have the full benefit of all the master's arrangements in practising his art, craft, or trade. The apprentice, on the other hand, although in the position of a servant to some extent, is not bound to serve as such, but may rather be said to be placed under the parental control of the master; and perhaps the master may (personally, but not by deputy) correct the apprentice's faults and disobedience by moderate chastisement, if the apprentice be still under age; but he cannot discharge the apprentice. The agreement on the part of the master is of the nature of a personal trust, and the indenture cannot be assigned by him, at all events without the infant's consent, or unless, as by the custom of London, such assignment be sanctioned by settled usage. The apprentice cannot abandon

the service unless the master desert him. Nor is the apprentice's misconduct in general a defence for the master in an action against the latter or his covenants. For though one may dismiss a mere servant for misconduct, a master cannot turn away an apprentice for ordinary misbehaviour, such as idleness or drunkenness, but he may discharge him for theft, or for any wilful injury (also in the City of London for gaming). If the apprentice run away and go into another person's service, the master is entitled to recover the full value of his labour, without deduction of the wages paid to the apprentice by his new employer. The master has also an action for the value of the apprentice's services against any one who entices him away or wilfully harbours him after his desertion, with a knowledge of his apprenticeship. As the infant is not bound at common law by his covenants, it is not unusual to take security from some responsible persons for the performance of the contract by the apprentice; and in such case the surety must be a party to the articles.

It remains to remark that the ancient system of apprenticeship is slowly dying out in this country, and is already nearly extinct in the United States. This was to be expected from the altered condition of society, especially since indoor apprenticeship has dwindled away. Lads now get taken as errand boys, from that are promoted to the workshop, and pick up their trade somehow. The consequence is the production of a class of workmen very inferior to the old men, who had been carefully instructed in every branch of their trade by their masters or foremen. And the *morale* of the workmen has suffered still more. Under the old system the youth was kept under strict control for the seven years from the age of fourteen to that of twenty-one, and did not receive his freedom, indeed, until he was in the eyes of the law a man.

This training, especially when the apprentice lived with his master's family, would be of infinite service, as indeed we see it was. The ancient apprentice when he "came out of his time" felt himself a man, rich alike in a competent knowledge of the trade and in habits of self-control and needful subordination. On the contrary, take the state of things where apprenticeship is neglected or little regarded. There is perhaps no trade where the evils of this neglect are more flagrantly exemplified than in printing in the metropolis. A lad, let us say, is apprenticed to the type-setting or as a "compositor," which is now a perfectly distinct trade to that of working at press or machine. He learns how to "pick up stamps," as they phrase it, or set type moderately well, in from six months to a year. His master is probably paying him six or eight shillings a week. Some elder lad puts him in the way to "better himself." This operation consists in leaving his master's shop and presenting himself at some other office where work is plentiful as a "turn-over" (*i.e.* one who leaving one master, in consequence of the employer's relinquishment of business, is "turned over" by the master's endorsation of the indentures to another employer). If busy the new printer will at once take him on "on his halves." This means that the youth is "on his lines," or "on the piece," and sets as much as he can, being paid for it just half the amount which would have been given to a journeyman. As a compositor is in his (working) prime at a very early age, the "turn-over" probably "sets" as much as a man could do, receives at the end of the week from 25*s.* to 30*s.*, and is thrown into a dangerous position of temptation. As he has probably deserted his home when he left his original master, he sets up on his own account, and after a few months of dissipation—drinking, billiard playing, and that especial curse of London, betting—he finds some silly servant girl, marries, and sets up home in a squalid London lodging-house, finding himself probably father of two or three feeble, rickety children before he has attained his legal majority.

This is no exaggerated picture; and looking at the evident deterioration of the type of young artizans of some trades, sensible men cannot help sighing for the good old days of strict apprenticeship. In fact, so strong is this feeling becoming in America, that we learn from recent issues of technical organs in the United States that the apprenticeship system is urgently recommended for immediate readoption.

In our next paper we will touch upon the duties, wages, etc., of some of the principal trades.

V.

THE SKIN (*continued*).

Chemical Nature of Hair.

THIS growth of the cuticle is constituted of peculiarly permanent substances, and is eminently fitted to resist destroying influences. It is included with the bones and teeth among the portions of the body which withstand decay longest after death. Some of the animal matter of hair resembles gelatine; another constituent is more like albumen, but contains a considerable proportion of sulphur. Fat also can be extracted from hair by alcohol and ether. The permanence of hair is no doubt partly due to the inorganic substances with which it is mingled, especially peroxide of iron and various salts of sodium, potassium, calcium, and magnesium; yet the total percentage of these is but small.

Distribution of Hair.

Hair is almost universally found over the human body, the only parts excepted being the palms and soles, the back of the tips of the fingers and toes, and the upper eyelids. They vary, however, in number, size, flexibility, and arrangement in different regions. They usually slope or lie nearly flat on the surface of the body, the direction being for the most part similar in the same region. It is owing

to this, and the slight amount of colour they contain, that we often fail to perceive them on parts where they really exist.

In children the hairs are usually quite short, except on the scalp; there, however, they may become particularly long, sometimes extending down to the feet. In women the hair of the head may remain quite long up to old age. We observe great differences in the flexibility and fineness of hair in various people. Some naturally have it straight, thick, and crowded; in some also it has a great tendency to the erect position. Others have very curved or curly hair, naturally arranging itself in beautiful locks.

Between the ages of twelve and fifteen, hairs on many situations of the body begin to grow to a greater length and thickness. Herein is a sexual difference, men almost invariably having a more copious growth of hair than women. Men exhibit the greatest contrasts in this respect; some seem as if their hairy covering were sufficient to protect them from intemperate weather. Their legs and thighs and upper limbs are closely covered with hair sometim es of considerable length. Hair in men has a very characteristic development in the middle line of the trunk, often occurring in large patches over the breast-bone, and continuing downwards in a straight line.

FIG. 10.—SEBACEOUS GLAND, WITH A SMALL HAIR ATTACHED. (*Greatly magnified.*)
1. Hair. 2. Sebaceous gland.

Albinos* present the singular and inexplicable phenomenon of a total absence of colouring matter; both cuticle and hairs have no pigment distributed in their cells, and even the choroid membrane of the eye has none, causing great difficulty in bearing anything like a bright light.

Albinos.

The Glands of the Skin.

The special glandular structures of the skin, which are of the highest importance, remain for consideration. The whole skin in one sense is a gland, for it continually forms and throws off the cuticle and the hairs; but the glands are more special than this, being constructed to separate various waste matters from the blood as it circulates. They are of two kinds—the sweat-glands and the fat-glands.

The sweat-glands occur all over the skin, but are much more numerous in some parts than in others. In the palm of the hand they are extremely abundant, one observer having counted about 2,800 on a square inch of that part. The sole of the foot has nearly as many, the back of the hand half the number. The order of abundance of sweat-glands on other parts has been estimated thus: forehead, front and sides of neck, breast, abdomen, forearm, lower limbs, back of neck and trunk. A square inch of the last contains from four to six hundred sweat-glands.

Distribution of sweat-glands.

These glands essentially consist of a tube prolonged from the cuticle into the dermis and through it into the looser tissue below. The lining of the tube is a continuation from the cells of the cuticle, which become softer and more rounded towards the bottom of the tube. The latter is rolled up into a coil, while the upper portion, passing through the cuticle, makes several turns like a corkscrew. The tube is bounded by fibres and membrane from the true skin, and there is a dense capillary meshwork of blood-vessels close underneath. Some of the sweat-glands in the armpit are much larger than the others, and several tubes open at one mouth; these also have muscular fibres in their wall.

Coiled tubes.

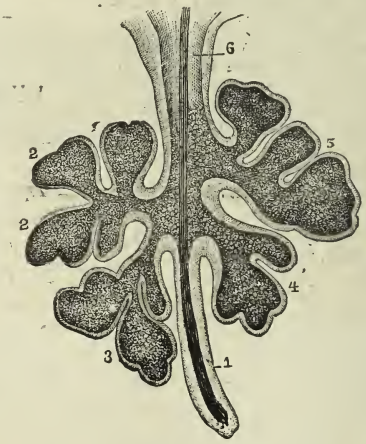


FIG. 11.—LARGE SEBACEOUS GLAND. (*Greatly magnified.*)
1. Hair in its follicle. 2, 3, 4, 5. Lobules of the gland. 6. Excretory duct traversed by the hair.

Sweat.

By means of the cells lining the sweat-glands, small quantities of watery fluid are regularly strained through the skin. In the small glands the secretion is simply water containing various salts such as common salt and waste products of decomposition. In some parts, as in the armpits, the secretion is distinctly thick and opaque, containing many granules and some fat.

Sweating is an ordinary relief to the system when more fluid is taken in than is needed to be retained. It acts also like a safety-valve to the system when heat is excessive, for the water poured out on the surface must evaporate, and in so doing it will take much heat from the body. This is a reason why clothing of a very close texture is so uncomfortable in hot weather, for evaporation cannot duly go on through it. When muscular work is heavy, the relief is the same; the combustion occasioned by the work produces excessive heat, which must be got rid of by the evaporation of water. A distinction is made between sweating that is *insensible*, when no moisture can be felt or seen on the outer surface of the skin, and *sensible*, when the sweat collects in smaller or larger drops. In the former case, the liquid is evaporated without accumulating so as to form a drop.

Sweating a relief in heat.

* Lat. *albus*, white.

The Fat-glands.

These are found accompanying hairs, their tubes opening into the upper part of the follicles. They are different from the sweat-glands in not penetrating through the dermis, and having a branched form. Each branch has at its end a number of small bulbous dilatations. The lining of the tube is derived from the cuticle, and almost fills up the interior; outside there is the dermis with an abundant blood supply. The secretion is to a great extent made up of minute fatty granules, which exude and supply a natural oil for the hair. To this is due the characteristic odour which is more or less strongly developed in the armpits of every one.

Fat.

In the deeper layers of the true skin, and in the looser tissue immediately beneath it, the formation of fat frequently takes place to a considerable extent, giving important characters to the skin and to its superficial appearance. Consequently, we judge it most desirable to speak of the subject in this place, although fat is found in many other situations in the body.

Fat in and beneath true skin.

In fact, it appears that the presence of some fat is inseparable from true living substance or protoplasm. In some way its existence is very closely bound up with our life. In protoplasm it is found very minutely diffused, generally appearing as exceedingly small specks, giving the living matter a granular appearance. It is to be met with in blood in this finely-divided form, and also in the replenishing fluid of the blood, chyle, which is brought from the digestive organs. So universal is it that it finds its way into many of the secretions, including those of the fat-glands just mentioned, and that of the liver, or *bile*.

Fat universal in protoplasm.

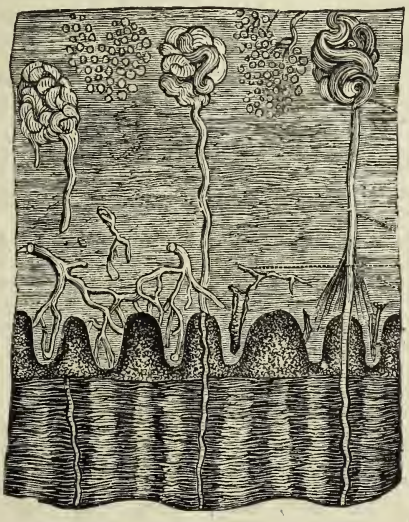


FIG. 12.—SECTION OF THE SKIN.
(*Same as fig.* 7, p. 620, *more highly magnified.*)

The general physical characters of fat we leave to the department of the chemist. It suffices for us to know that fats are met with in nature both as solids and as liquids, and that animal fat has most usually the character of a liquid when in the living body. If the entire amount of fat in most human bodies were collected together in one mass, it would occupy a very considerable space. Supposing it were quite free from enclosure in the body, it would have a tendency to gravitate as a fluid, so that we should feel the position of our weight of fat to be very much altered after a night's rest or a hard day's work. There would be too much possibility of rapid change in our proportions if fat had a power of free motion in our bodies.

Liquid fat would move if unconfined.

But every one will have noticed in eating or cutting animal fat that it contains more or less of a stringy substance which is not fat. This is called connective tissue, and we thus recognise the large bands of it which form a network around and within the fatty masses. The network extends into fine branchings, so that the fat is minutely beset with the connective fibres.

How kept in position.

This is not all, for the fat is further divided up among very minute cells. And its enclosure is brought about by the increased absorption of fat from the blood into a simple minute vesicle bounded by a thin membrane and containing protoplasm. The fat accumulates, and shows in larger and larger drops; the cell gets distended, and finally appears as nothing but a little bladder filled with fat.

Fat-cells.

These fat vesicles are grouped together so as to form little clusters, or lobules; and these again are so disposed as to be visible as small rounded masses with smooth surfaces. The lumps are lodged in the larger meshes of the connective tissue we have spoken of. The multiplication of these gives rise to the masses of fat seen in various regions.

Lobes of fat.

Blood-vessels are abundantly supplied to fatty tissue; small arteries pass to each lobule and divide up into the minutest vessels, which enter between the fat-cells and interlace, so that nourishment is brought continually within their reach. Also, and most important for the bodily organization, the fat can be carried away, if wanted, being absorbed in minute quantities at a time by these same fine vessels, and conveyed away for the nutrition of other parts by the veins. It is not known that fat is in any way sensitive, or that nerves are distributed to it directly. No pain is caused by pricking fat itself.

Fat nourished by blood-vessels.

Uses of Fat.

It is well known that people who have a considerable store of fat can maintain life, when starved, for a longer period than those who are thin. They, in fact, feed upon themselves, upon their internal reserve stores of food. Again, in the case of animals that hibernate, or pass through a winter sleep, it is found that

Fat a store of food.

the coating of fat with which they lie down in the autumn becomes much diminished in their long winter's rest, although the vital powers are reduced during that period of the year to the lowest amount of exercise compatible with existence.

We readily comprehend the mechanical value of fat. It is lighter than water, so that it constitutes a very serviceable packing and padding material. The liquid material is contained in elastic cell-membranes, and so readily accommodates itself to alterations of posture, except in the case of those who are said to be literally "bursting with fat." Thus it is well adapted to give support to parts which constantly require to be moved; it is accumulated around joints, and in the abdomen, where the alternate breathing in and out of air by the lungs occasions regular movements. The same quality of elasticity likewise makes fat very suitable as an aid in resisting pressure, not only in cases where the pressure comes from the outside, but when it happens to originate from within.

Packing material.

XLVIII.

Study for Reading and Pronunciation.

This study consists of a number of short distiches, by Schiller, each containing some maxim, precept, or thought. Schiller and his friend Goethe at various times wrote a great number of such couplets, which were published under the name of "Xenien." With the exception of the first and second, which are connected, it will be seen that all these distiches are separately complete in themselves. The first line is always a hexameter, or line of six feet, consisting of spondees, or two long syllables, and dactyls, or tri-syllabic feet, with a long syllable followed by two short ones. The second is a pentameter line, or one of five feet, one of the feet being divided, the first half appearing in the middle and the second at the end of the line. Thus:

Hālte dăs | Bĭld dĕr | Würdĭgĕn | fĕst! Wĭe | leŭchtĕndĕ | Stĕrnĕ |
Thĕĭltĕ sĭe | aŭs dĭe Nă-|tür, dŭrch dĕn ŭn-|endlĭchĕn | Raŭm.

Both Schiller and Goethe were happy in concentrating various truths in such distiches, many of which have become proverbial in Germany.

Sprüche.
sprue'-che

Warum bin ich vergänglich,[1] o Zeus? so
vah'-room bin ich fer-geng'-lich o tsois zo
Why am I fleeting, O Zeus? so

fragte die Schönheit.[2]
fraach'-te dee shoen'-hite
asked (the) Beauty.

Macht' ich doch,[3] sagte der Gott, nur
macht ich doch zaach'-te dare got noor
Made I yet, said the God, only

das Vergängliche schön.
dass fer-geng'-li-che shoen
the fleeting beautiful.

Und die Liebe, die Blumen, der Thau und
unt dee lee'-be dee bloom'-en dare tow unt
And (the) love, the flowers, the dew and

die Jugend vernahmen's;[4]
dee yoo'-gend fer-nah'-mens
(the) youth heard it.

Alle gingen sie weg, weinend, von
al'-le ging'-en zee veeh vy'-nend fon
All went they away, weeping, from

Jupiter's Thron.
yoo'-pitt-ers tronc
Jupiter's throne.

Früchte bringt das Leben dem
fruech'-te bringt dass lay'-ben dame
Fruits bringeth (the) life to (the)

Mann; doch hangen[5] sie selten
mann doch hang'-en zee zel'-ten
man; yet hung they seldom

Roth und lustig am Zweig, wie uns ein
rote unt lust'-ich am tsviche vee uns ine
Red and cheerful on the twig, as us an

Apfel begrüßt.[6]
ap'-fel be-gruesst'
apple greets.

Kinder werfen den Ball an die Wand,
kin'-der vairr'-fen dane ball an dee vand
Children throw the ball at the wall,

und fangen ihn wieder;
unt fang'-en een vee'-derr
and catch it again;

Aber ich lob' mir das Spiel, wirft
ah'-berr ich lobe meer dass speel virrft
But I praise me the game throws

mir der Freund ihn zurück.
meer dare froint een tsoo'-rueck
me the friend it back.

Halte das Bild der Würdigen[7] fest!
hall'-te dass bild dare vuer'-di-chen fest
Hold the picture of the worthy fast!

Wie leuchtende[8] Sterne
vee loich'-ten-de schter'-ne
Like illumining stars

Theilte sie aus die Natur durch
tilr'-te zee owss dee nah'-toor doorch
Distributed them (out) (the) nature through

den unendlichen Raum.
dane un-end'-lich-en rowm
the endless space.

Wem zu glauben ist, redlicher[9] Freund,
vame tsoo glow'-ben ist rayd'-lich-er froint
Who to be believed is, honest friend,

das kann ich Dir sagen:
dass kann ich deer zah'-gen
that can I to thee tell:

Glaube dem Leben; es lehrt beßer als
glow'-be dame lay'-ben ess layrt bes-ser als
Believe (the) life; it teaches better than
Redner[10] und Buch.
rayd'-ner unt booch
speaker and book.

Wißt ihr, wie auch der Kleine was
visst eer vee owch dare kly'-ne vas
Know ye how also the little (one) something
iſt? Er macht das Kleine
ist airr macht dass kly'-ne
is? He does the little
Recht; der Große begehrt juſt[11] ſo das
recht dare gross'-e be-gayrt' just zo dass
Right; the great (one) demands just so the
Große zu thun.
gross'-e tsoo toon
great to do

Wer iſt denn wirklich ein Fürſt?[12] Ich
vare ist denn veerk'-lich ine fuerst ich
Who is then really a prince? I
habe es immer geſehen,
hah'-be es im'-mer ge-zay'-en
have it always read,
Der nur iſt wirklich Fürſt, der es
dare noor ist veerk'-lich fuerst dare es
He only is really prince, who it
vermochte[13] zu ſein.
fer-moch'-te tsoo zyne
was able to be.

REMARKS ON THE FOREGOING STUDY.

[1] *Vergänglich* comes from the verb *vergehen*, to go or pass away; thus beauty is *vergänglich*, fleeting or transitory. Thus *Eine Stunde verging*, an hour passed away.

[2] *Die Schönheit*. In speaking of things in a general sense, beauty, truth, gratitude, etc., the definite article is used in German, as in French: *Die Tugend gibt den wahren Frieden*, Virtue gives true peace. In speaking partitively, the article is not used: *Er hat Tugend*, He has (a certain amount of) virtue.

[3] The word *doch* is used here as an expletive, to strengthen the sense generally, without any definite meaning of its own: *Kommen Sie doch, meinen Freund zu besuchen, Just* come and visit (*do* come and visit) my friend.

[4] *Vernehmen* (from *nehmen*, to take, literally to take in, become aware of a report): *Ich habe mit Schmerzen vernommen, dasz es ihm so schlecht geht*, I have heard with pain, that it goes so badly with him.

[5] Notice the difference between the intransitive verb *hangen* (imp. *hing*, past part. *gehangen*), to be in a state of hanging; and the transitive *hängen* (imp. *hängte*, past part. *gehängt*), to perform the action.

[6] *Grüszen* is the English "to greet"; the prefix *be* renders the verb transitive. *Grüszen*, to greet generally, to utter a greeting: *Jemanden begrüszen*, to salute some one individually.

[7] The word *Menschen*, or *Leute*, men or people, is here understood.

[8] *Leuchten* (from *das Licht*), to diffuse light or radiance: "*Ist es gleich Nacht, so leuchtet unser Recht*," "Though it is night our right diffuses radiance" (Schiller's *Wilhelm Tell*). Thus we have *leuchtende Sterne*, gleaming stars, giving light.

[9] *Redlich—ein redlicher Mann*, a man of good counsel, honest in principle: "and recks not his own rede" (*Shakespeare*).

[10] *Der Redner*, the orator: *Er hat eine Rede gehalten*, he has made a speech.

[11] *Just* is strictly speaking not a German word. The German expression would be *eben*, or *gerade*. *Just*, the French *juste*, is one of the expressions imported into German from the French language, which at one time was mingled with it to an absurd extent.

[12] Note the difference between *der Fürst*, the ruling prince, and *der Prinz*, a member of a princely family. *Der Fürst* is the foremost, the first in the nation.

[13] *Vermögen*, as a verb, means to have power, to be in a position to do anything; hence *das Vermögen*, the property: *Er hat sein Vermögen verloren*, he has lost his property. It is irregular, like the auxiliary of mood *mögen, mochte, gemocht*.

XIII.

AFRICA.

AFRICA forms the vast south-western peninsula of the Old World continent, is connected with Asia by the narrow isthmus of Suez, and surrounded on all other sides by the sea: namely, the Mediterranean on the north, separating it from Europe; the Atlantic Ocean on the west; the Atlantic and Indian Oceans on the south; and the Indian Ocean and the Red Sea on the east. It is situated between lat. 37° 20′ N. and 34° 50′ S., and long. 17°32′ W. and 51° 22′ E., being about 5000 miles in length, from north to south, by 4800 in greatest breadth, and having an area estimated at about 12,000,000 square miles, or more than three times that of Europe. Population estimated at over 200,000,000. The coast-line, which altogether is only about 16,000 miles in length, has remarkably few bays or promontories,—the principal of the former being on the north the Gulf of Sidra; west, the Gulf of Guinea, and the Bights of Benin and Biafra; and east, the Bays of Delagoa and Sofala: of the latter, on the north Capes Bon, Ras-el-Kerun, and Spartel; west, Capes Cantin, Blanco, Verd, Palmas, Formosa, and Negro; south, Cape of Good Hope, and Cape Agulhas; and east, Capes Corrientes, Delgado, and Guardafui. Notwithstanding the progress that has of late years been made in opening up the interior of Africa, large areas of it still remain altogether unknown. It is regarded as a vast tableland, bordered by mountain ranges towards the coasts. In Southern Africa the general elevation of the land is about 3000 feet above the level of the sea; while in Northern Africa the elevation is not so great, averaging from 1000 to 1500 feet. The greater part of Northern Africa is occupied by the Sahara, or Great Desert, which extends across the country from the vicinity of the Atlantic to the valley of the Nile. This region does not present one uniform, flat, sandy appearance, but frequently rises into hills; and though for the most part characterized by want of water, it has—especially in the eastern portion—many springs, which give rise to the fertile patches of ground called oases. Between the Sahara and the Mediterranean is the Atlas mountain range, which extends from Cape Nun on the Atlantic in a north-eastern direction through Morocco, Algiers, and Tunis to the Gulf of Cabes on the Mediterranean. The loftiest summit is Mount Miltsin, 11,500 feet. An elevated table-land extends from the Gulf of Cabes along the frontiers of Tripoli. From the Isthmus

of Suez a chain of heights stretches southward along the shores of the Red Sea, till in the Abyssinian highlands they attain a height of 12,000 to 15,000 feet. Farther southward, between the Indian Ocean and the great lakes, is the plateau from which rises Mounts Kenia and Kilimandjaro, 18,000 and 18,700 feet above the sea. Farther south the Drakenberg range rises steep and wall-like from the coast, and leads round to the terraces which form the Cape Colony. Along the western side of the continent, from Cape Colony to the Bight of Biafra, terraced ascents lead from the sea-coast to the interior table-land. The Kong Mountains extend from east to west along the coast of Guinea. The only important river of Northern Africa is the Nile, which rises in the Lake Victoria Nyanza, under the equator, and afterwards enters the Albert Nyanza. During its northward course it receives the Bahr-el-Azrek, or Blue River, which was formerly believed to be the true Nile, and the Akbara; and at last, after a length of more than 3000 miles, falls into the Mediterranean by several mouths. The Niger rises as the Joliba in the Kong Mountains. to the north-east of Liberia, and after flowing north-east to Timbuctoo, turns first east and then south-east, receiving the name of Quorra, and falling into the Atlantic near the Bight of Benin. Its principal affluent is the Binue, from the east. The Congo, or Zaire, which brings down the largest body of water of any of the African rivers, rises in Lake Bangweolo as the Luapula, traverses Lake Moero, is joined by the Lukuga, which drains Lake Tanganyika, receives the Lualaba, takes this name, and finally falls into the Atlantic Ocean. The only other important rivers on the west coast are the Senegal and Gambia, Coanza, and Orange River. The principal river of Eastern Africa is the Zambezi, which rises in Lake Dilolo under the name of Leeba. It afterwards receives the Leecambye, and further on the Chiobe. At the magnificent Victoria Falls it has a descent of one hundred feet. It afterwards receives the Kafue, the Loangwa, and the Shiré,—the outflow of Lake Nyassa,—and finally reaches the ocean after a course of 2,400 miles. The second in size of the rivers of Eastern Africa is the Limpopo. The lakes of this continent are numerous, and many of them are of great size. The principal are Victoria Nyanza, Albert Nyanza, Tanganyika, Tchad, Dembea, Nyassa, Ngami. Lying almost entirely within the torrid zone, Africa is the hottest of all the continents, but owing to the general elevation of the surface, the heat is not so great as it otherwise would be. A great part of the north and south, particularly in the interior, suffers from want of rain, but the central region is well supplied with moisture, and in consequence has a luxuriant vegetation. The low-lying regions on the coast are, in general, very unhealthy. The vegetable productions of the north of Africa resemble those of the south of Europe. Wheat, barley, and maize are cultivated; while oaks, pines, cypresses, etc., are the common trees. The Sahara is the peculiar region of the date palm, which furnishes food for both men and animals in the desert. South of the Sahara the gigantic baobab, or monkey bread-tree, takes the place of the date-palm, and the place of corn is supplied by the cassava, yam, ground-nut, etc. Wheat and other kinds of grain are grown in the south of Africa, but the most characteristic plant of this region is the heath, of which there are large groves, rising often to the height of twelve or fifteen feet. Among the wild animals are the elephant, rhinoceros, hippopotamus, crocodile, lion, panther, jackal, hyæna, giraffe, zebra, various species of goats, the chimpanzee, gorilla, and numerous other kinds of monkeys. Among the feathered tribes are the ostrich, guinea hen, partridge, quail, owl, falcon, and vulture. Gold appears to be widely diffused; it is found in many parts, and important gold-fields exist in the Transvaal region. Iron abounds in Algeria. Copper is found in Central Africa and also in the Cape Colony. Salt is found in many localities, and is the most valuable mineral product of the Sahara. A few years ago important diamond fields were discovered on the northern borders of the Cape Colony. The principal races inhabiting the north of Africa are the Berbers, who occupy the Atlas range and the oases of the desert; the Moors, who inhabit the cities and towns of the Mediterranean; and the Arabs, many of whom, as ivory and slave traders, extend their journeys far into the interior of the continent. Central Africa is inhabited by the Negro race, characterized by their black woolly hair, protruding lips, and flattened noses. In the south the leading races are the Hottentots and Kaffirs. The following are the principal states of Africa:—

BARI.

EGYPT is situated in the north-east of Africa, and extends from the Mediterranean southward to the equator, embracing, besides Egypt Proper, Nubia, the Egyptian Sudan, Kordofan, and Darfur. The total area is 1,153,000 square miles, and the population 17,400,000; of which Egypt Proper has 394,000 square miles, and 5,517,627 inhabitants. It is governed under the Ottoman Porte by the Khedive, whose power is hereditary and practically absolute. A great part of this region consists of sandy desert, the

cultivated portion being confined to the country affected by the annual innundations of the Nile. At Cairo the rising begins in the middle of June, and generally reaches the maximum in October, after which it begins to subside. Wheat and rice, the sugar-cane, cotton, and indigo are the chief products. In 1880 the total imports were £6,713,000, of which nearly one-half were from the United Kingdom; and the exports £13,307,000, of which nearly three-fourths were to the United Kingdom. The revenue and expenditure for 1881 were each estimated at over £10,000,000; and the public debt was £98,000,000. The army numbers about 20,000 men, and the navy consists of ten vessels of war. Cairo, the capital, has 327,500 inhabitants.

TRIPOLI, including *Barca* and *Fezzan*, is a vilayet, or province, of the Turkish Empire situated on the northern coast of Africa, to the west of Egypt. Its area is estimated at 379,000 square miles, and its population at about 1,010,000. The capital, of the same name, has about 25,000 inhabitants.

TUNIS was formerly a tributary province of the Turkish empire, governed by a bey, but a French resident has lately been established here, under whose control the bey now virtually is. It has an area of 44,900 square miles, and about 2,100,000 inhabitants. Agriculture is not much attended to, but cattle are reared in large numbers, and the manufactures of silk and woollen goods, shawls, carpets, mantles, red caps, leather, and pottery, are considerable. The chief town, of the same name, has about 125,000 inhabitants, and carries on a very considerable trade.

ZULU KAFFIRS.

ALGERIA, or ALGIERS, the largest and most important of the French colonial possessions, is bounded north by the Mediterranean, east by Tunis, south by the desert of the Sahara, and west by Morocco. It has an area of 165,980 square miles, and 2,868,000 inhabitants. Along the Mediterranean the country is fertile and well cultivated, and the productions are similar to those of other Mediterranean countries, including wheat, barley, grapes, olives, oranges, cotton, flax, tobacco, esparto grass, vegetable horsehair. In 1879 the imports amounted to £8,560,000, and the exports to £7,112,000. The country is rich in iron and other minerals,

MOROCCO is situated to the west of Algeria, and in the north-west of Africa. It is the largest of the Barbary States, having an area of about 260,000 square miles, with a population estimated at about 6,000,000. The sultan, or emperor, is independent, and his power absolute and despotic. Among the chief products are wheat, barley, and maize, esparto grass, hemp, olives, oranges, figs, dates, pomegranates, lemons, etc. It is said to be rich in minerals, but these as yet have been greatly neglected. The principal manufactures are leather and red caps, named after its chief town Fez, which has about 150,000 inhabitants.

ABYSSINIA, a country in the north-east of Africa, rising abruptly from the low-lying country on the south-west coast of the Red Sea. It consists of a series of plateaux from 5000 to 8000 feet in height, from which rise groups and ranges of mountains, the loftiest summit being about 15,000 feet above the level of the sea. The climate is generally mild and healthy; and the productions are maize, wheat, barley, coffee, the sugar-cane, cotton, dates, oranges, grapes, etc. Population about 3,000,000.

SENEGAMBIA is the name commonly given to the maritime region of Western Africa, watered by the rivers Senegal and Gambia. It is occupied by various negro tribes, and the French, English, and Portuguese have settlements here, the English being Sierra Leone, etc.

LIBERIA, a negro republic founded in 1827 for the reception of free negroes from America, extends for about 400 miles along the coast of Guinea, and on an average about 100 miles inland. Population, 1,068,000; capital Monrovia.

GOLD COAST, THE ENGLISH COLONY OF THE, extends for about 300 miles from east to west along the northern coast of the Gulf of Guinea, and on an average about thirty miles inland. Population, 520,000. The oil palm grows here in great profusion, and oil, gold, ivory, gum copal, and monkey skins are among the principal exports. The chief station is Cape Coast Castle.

CAPE COLONY occupies the extreme southern portion of Africa, and is washed on the west and south by the Atlantic and Indian Oceans, having on the north the Orange River, to the west of 22° E. long. It is about 170 miles in length by about 500 in breadth, and has an area of 240,000 square miles, with 1,250,000 inhabitants. The surface of the country rises from the coast in a series of terraces, which are marked off by ranges of mountains running east and west, and varying in height from 4000 to 8000 feet. Beyond the country gradually declines to the Orange River. The rivers are mostly of small size and of little use for navigation, being in general furious torrents after rain, and at other seasons nearly dry. The climate is mild and dry, with a very uniform temperature, and is well adapted for Europeans suffering from pulmonary complaints. The principal mineral productions are manganese, copper, and diamonds (in Griqua-

land West). The produce of the diamond mines in 1880 is given at about £10,000,000. The chief grain crops are wheat, maize, oats, barley. The rearing of horses, sheep, cattle, and ostriches, and vine culture, are extensively carried on. In 1880 the exports (exclusive of diamonds and specie) amounted to £4,341,017; imports, £7,648,863; revenue, £3,541,720; expenditure, £3,742,665; public debt, £10,583,759. The capital, Capetown, has 45,000 inhabitants.

NATAL is situated on the south-east coast of Africa, having a seaboard of over 200 miles towards the Indian Ocean. It has an area of 18,750 square miles, and a population of 361,537. The country is for the most part mountainous, and well wooded, and the climate is agreeable and healthy. Wheat, oats, maize, coffee, sugar, etc., are produced, and horses, sheep, and cattle are numerous.

ORANGE FREE STATE, a South African republic of Dutch Boers and others who have established themselves in the country lying between the two head streams of the Orange River, and having south, Cape Colony; north, the Transvaal Republic; and east, Natal. It has an area of 42,470 square miles, and 133,518 inhabitants, chiefly engaged in pastoral pursuits.

TRANSVAAL, THE, is a South African Boer republic under the suzerainty of the British crown, lying, as the name implies, beyond the Vaal River, which forms its southern boundary, separating it from the Orange Free State. Its area is estimated at about 114,360 square miles, and the population at 300,000. Gold, copper, lead, iron, and coal are found, but the chief wealth of the country is in cattle.

MADAGASCAR, an island lying off the east coast of Southern Africa, from which it is separated by the Mozambique Channel. It is 980 miles in length by 360 in greatest breadth, and has an area of 228,570 square miles. Population about 3,000,000. A chain of lofty mountains traverses the island in the direction of its length. The soil is generally fertile, with rich pasturage and magnificent forests. Gold, silver, copper, lead, iron, and coal are found. The climate is hot and unhealthy to Europeans, especially along the coasts. The chief vegetable products are rice, sugar, cotton, indigo, tobacco, pepper, bananas, cocoa-nuts. A considerable export and import trade is carried on. The government is in the hands of a queen, and Christianity has made great progress here of late years.

EDUCATION FOR YOUNG WOMEN.

By M. J. H. GWYNNE BETTANY.

I.—SELF-EDUCATION.

WHEN a girl leaves school, far from being "finished," as her teacher and admiring parents express it, she is on the borders only of what may be called a thorough education. Whether she ever enter that most desirable land, depends now to a very great extent upon herself. Too many girls at this point rest contented with present attainments; others would set about educating themselves if they knew how, or if they had some friend at hand willing and able to give them practical hints on the subject.

First let us assure those girls who devote themselves to embroidery and such like trifles, to the exclusion of intelligent pursuits, on leaving school, that they are throwing away chances which in the future they may most bitterly regret. Too late they may discover that while youth and beauty are but transient passports to the good opinion of those they love, a cultivated brain and heart are charms that increase with years. Youth is the time when the mind acquires easily, or comparatively so, whereas every year after sixteen makes study more difficult unless the brain has acquired the habit of taking in new facts.

Education is not merely the heaping up of facts in the mind,—it is far more the encouraging and developing of *accurate observation*, and the power of *thought*, without which no book-reading can ever educate. It is the lack of this quality in many women which leads them to be unduly influenced by the opinions of people with whom they come in contact.

Girls with but little time at their disposal can, if they set themselves methodically to work, attain great things in education. Many of the most successful scholars have educated themselves with scant time for study. Much more depends on the quality of work done than on the time spent in doing it.

In choosing subjects for special study, a girl should be guided in some measure by her tastes. As, however, her tastes may be what is termed universal, not leading her to choose any definite line, it will be well to indicate what subjects ought to be taken up by a girl who wishes to have a claim to the title of a well educated woman.

If Latin grammar has not been already commenced, no time should be lost in making a start, for one cannot get an accurate knowledge of any modern language without a tolerable familiarity with Latin. And to be able to read freely other languages than our own gives us the power to profit by the high-class literature of other countries.

English literature, however, should be studied before spending much time upon foreign works. Take a play of Shakespeare, say *As You Like It*, with good notes, and do not rest till you feel satisfied you understand it as well as possible. Then, and not till then, take another in the same way. A great help to understanding literature is to read up carefully the period of history in which the author lived. In the same way read the *Spectator*, Milton's "Paradise Lost," Johnson's "Lives of the Poets," several of Locke's works, such as the third book of his Essay on the Human Understanding, his Essay on Education, and on the Conduct of the Understanding, and

Bacon's Essays. Goldsmith's "Traveller" and "Deserted Village," and Thomson's "Seasons," may be mentioned as examples of poems which are as worthy of careful reading as more solid works.

When the older classic English authors have been mastered, get up also a history of English literature by some well-known writer, such as Stopford Brooke or Professor Morley. Thus you will gain experience and guidance which may enable you to choose among the varied productions of the present century.

We would urge upon girls the necessity of becoming sound arithmeticians, for though it may be argued that girls cannot talk arithmetic, or make any very practical use of it, unless they need it directly in earning their own living, yet its influence upon the mind is excellent. There is nothing that will so surely train a girl's mind to be logical and accurate as arithmetic.

At least two books of Euclid should be mastered. In learning Euclid do not simply read through a proposition and refer to the figure in the book, but begin by drawing the figure yourself, line by line, as the book directs in the construction. When the figure is complete, follow the argument by constant reference to the figure, and be sure you *understand* it, for you may as well learn a set of meaningless words as get up the words of a proposition without having at the same time a grasp of the meaning.

The reading of good biographies of eminent persons is most instructive ; and books of travel are very essential in helping one to realize what foreign countries are like ; they have, besides, a tendency to widen the sympathies, which is in itself an excellent education.

We must introduce *fiction* as a means to this end. The novels of Thackeray, Dickens, George Eliot, and Charlotte Brontë, educate the sympathies, and do away with a great deal of the narrow-mindedness which detracts so much from a fair and sound judgment. In fiction we learn to understand and feel a keen interest in classes of people we should otherwise treat with indifference or disdain. Of course low fiction has not this merit, but on the contrary fills the mind with wrong notions of life, besides being generally inaccurate in most other respects.

The study of physiology is of immense value to girls, and we can promise those who know nothing of it that they will find it highly interesting. The more it is followed the more fascinating it becomes.

Natural history is also within easy reach of most girls. Many good and cheap books are written upon this subject, but more may be learnt by the observation of the living creatures you meet with in your walks or otherwise. This is, of course, more feasible in the country than in the town. If there is a pond accessible, it will be found highly amusing as well as instructive to watch the little creatures who make it their home, and learn by actual experience the metamorphoses they pass through. In the summer it will be both a pleasant occupation and of educational value to read botany and collect specimens of the different orders. Carefully examine all the plants you find, and separate the parts so as to get acquainted with their exact structure. In a similar way a good deal of geological knowledge may be obtained. Read with care the geology given in the UNIVERSAL INSTRUCTOR, then make little expeditions in and around the neighbourhood you live in, equipped with a small hammer, and collect for yourself such fossils or specimens of rock or stone as you can find.

For girls of artistic tastes there is plenty of scope for self-education. It is advisable, in order to properly understand the present position of art, to trace its history as far back as possible in its various branches. Read the biographies of the most celebrated painters and sculptors, and lose no opportunity of seeing and studying their actual works that may present itself. Here let us remark that a cursory glance at a picture is not studying it. One must sit before it and let it grow upon the mind, and so give oneself the chance of catching a glimpse of the master soul who painted it.

To look thus at works of art, and read the poem they all contain, is in itself an inspiration : and one can sit down to the easel without any discouragement, but with added patience, being content to make our own work the best our capabilities and opportunities allow of.

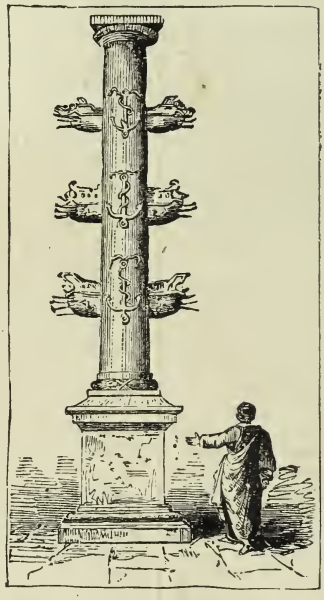
Do not, as is so much the fashion among girls, hurry to finish and get framed pictures which, though fair attempts, might have been much better. Slovenliness pays as little in art as in anything. Everything we do our very best is an educational gain, in a general sense as well as in a particular one. Everything indifferently done is a clear loss of power, and to some extent detracts from the future attainment which is the combined result of single efforts, and in which we can never precisely estimate the value of each particular effort.

As to music, it is too frequently pursued by girls in an unintelligent fashion, although it may and should be made a most intellectual discipline. By musical education we do not mean the playing, more or less indifferently, of airs with variations, or, what is worse, mutilating a grand sonata by a master composer, but a patient, persevering fight with the technicalities, the careful training of the fingers to ready obedience, and the searching out of the composer's thought in a movement, the making yourself one with the composer for the moment, and *so* rendering his work worthily. It is a question if this can be done unless the musical student reads and masters something of harmony. Harmony, though at the outset appearing somewhat dry and tedious, becomes most interesting as one progresses, and any labour it costs is amply repaid in the increased power of rightly interpreting a composer.

Do not become discouraged, however little you seem to master in a given time ; but rest assured that an infinitesimal amount thoroughly understood, and gone over times enough to secure its being retained, is worth more than a large quantity imperfectly comprehended, and consequently ill remembered.

If possible, have a fixed time for study, for nothing is more common than for work to get shirked altogether some days unless there is a definite time allotted to it. This must of necessity involve some sacrifice; for all kinds of seemingly legitimate excuses will daily present themselves to hinder methodical study. But an absolute rule should be made, and pleasure should be cheerfully sacrificed for such a great end as the cultivation of the mind. Besides, the sacrifice is in reality non-existent, for the gain of happiness on the worker's side is greater than the imagined loss.

There is nothing so effective in producing cheerfulness, and warding off *ennui*, as some compulsory task. And as cheerfulness is most beneficial to the bodily health, it is to be inferred that mental work is healthy in its effects. Of course this does not apply to overwork, which is a great evil. For this reason girls should watch themselves carefully after work, and if they are depressed, or have a headache, it would be well to shorten the time or change the hour of study. The morning is really the best time for study, between the hours of nine and twelve; for the faculties are fresh from sleep and from the bath, and one acquires much better in consequence. Some have found it advisable to work only half an hour at a time at any given subject, — not leaving off working, however, but taking another subject, as different as possible from the last. This change rests the mind from a strain in a particular direction, and the student can by this means get over more ground.



COLUMN OF DUILIUS.

It is to be remembered that plenty of walking exercise is necessary for students, and the daily walk should be as diligently kept up as the hours of study. To work in the evening cannot be considered the best plan, but for some no doubt it is a necessity. To such we would say, do not on any consideration work during the last hour before going to bed, as the brain does not become composed enough to allow of sleep, and even in cases where sleep is attained it is often unrefreshing. Do not be persuaded to keep late hours, for it is of no use to expect a tired or but partially refreshed brain to take in new facts and properly assimilate them. By following these suggestions you may expect to find that habits of thoroughness in study can be more easily formed than many girls seem to believe.

Our next paper will treat of colleges for women and of those public examinations for women which constitute so interesting a feature of the educational progress of our times.

ANCIENT HISTORY.

XLIII.

ROME (*continued*).

VERY soon after the Gauls had ceased to trouble Rome, she became engaged in a great war, or series of wars, lasting for half a century, with her powerful neighbours the Samnites, who dwelt east of the Latins, occupying the Apennines and the country between them and the Adriatic. They were the most formidable rivals for supremacy in Italy that Rome had yet encountered, and for fifty years it was doubtful which of the two nations would be mistress. The first Samnite war was unimportant, and the Romans were glad to end it in order to settle with their late allies, the Latins, who now declared they would no longer be the subjects of Rome but her equals, sharing the government equally with her. This proposal Rome would not agree to, so war was declared by the Latins. This Latin war lasted three years, and ended in the triumph of the Romans, after the heroic self-devotion of the consul Decius Mus, who, when the oracle declared that victory would be on the side of the army whose general was slain in the fight, rushed headlong into the midst of the Latins, and was immediately cut down. The Latins were then reduced to a condition of entire dependence on Rome, but were otherwise generously treated. Their cities were not allowed to trade with each other, but only with Rome; and the people were promised that in time, if they behaved well, they would be admitted to equal privileges with Romans.

The Samnites.

Latin war.

In 327 B.C. the second Samnite war broke out, and lasted for over twenty years. The chief incident in it was the capture of a Roman army, with the two consuls, by Pontius, the Samnite general. They were decoyed into a narrow defile of the mountains, where the Samnites surrounded them and compelled them to surrender and pass under the yoke in token of defeat. But the Romans fought on until the year 304, when a peace was made, which lasted only three or four years. In 300 B.C. began the third and last Samnite war, the greatest of the three. This time all Rome's enemies seem to have combined to crush her dangerous power, but in vain. Gauls, Etruscans, and

Second Samnite war, B.C. 327.

Samnites were all beaten in a great battle, and finally the great and generous Pontius was taken prisoner and cruelly put to death by the Romans. Then the Romans felt they were supreme in central and southern Italy. But in the extreme south there were a number of wealthy Greek colonies which as yet had hardly come in contact with the power of Rome, and were determined not to submit to her without a struggle. But feeling too weak to face Rome by themselves, they sent to Pyrrhus, king of Epirus,—the country on the opposite coast of the Adriatic, north of Greece,—and offered to pay him well if he would bring his army and fight for them. Pyrrhus came with a large and highly-trained army. It was the first time Romans met an army from beyond Italy, and their troops were beaten by the more disciplined soldiers of Pyrrhus. But though beaten they had given their conqueror a wholesome dread of meeting them; and it is recorded that his losses were so great that after the battle he said, "A few more such victories and I am ruined." So he tried to make terms of peace with the Romans, but they told him with great spirit they would never make peace with him so long as he remained on Italian soil. At last he was beaten in a great engagement, the Romans having learned by frequent battles his mode of warfare, and how best to meet him; so he was obliged to quit Italy, having lost almost his whole army. The departure of Pyrrhus and the consequent submission of the Greek cities of the south left Rome undisputed mistress of all Italy south of the land of the Gauls. Her citizens were the rulers of Italy. The Latins were allowed some of the privileges of Roman citizens, but the rest of the Italians, though they were allowed a good deal of self-government, were subject to Rome and had to serve in her armies.

War with Pyrrhus, B.C. 280.

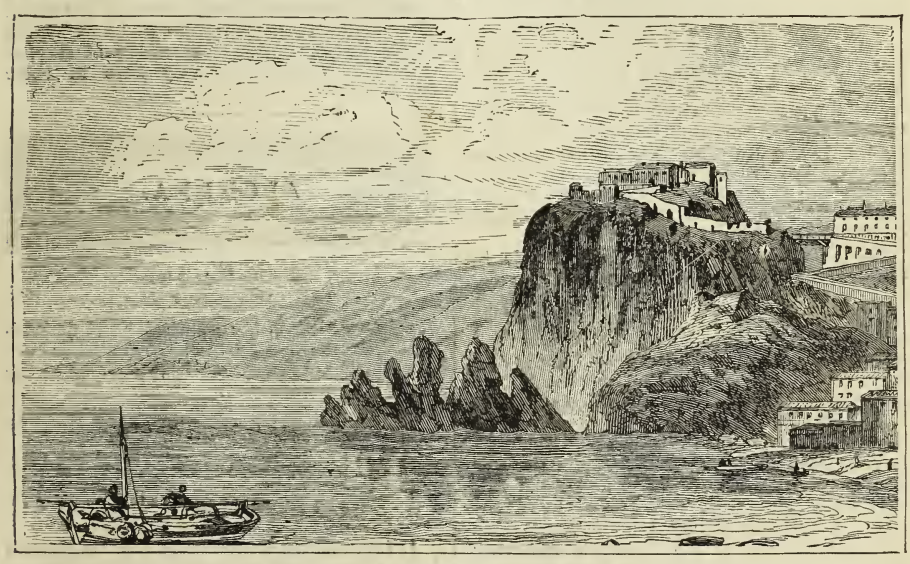
Rome mistress of Italy.

To keep them in order and to strengthen her hold on them, she planted colonies, or settlements of Roman citizens, all through Italy, and made great highroads through the country, all leading straight to Rome, so that an army could be despatched to any part of Italy in what was then a very short time.

Italian colonies.

Rome had now become so important that henceforth her great struggles were with nations outside of Italy. And the question was no longer whether she should be the chief power in Italy, but whether she should become the chief power in Southern Europe.

The first of these struggles, and perhaps the most severe of all, was with Carthage,—a struggle of life and death, which ended after about a hundred and twenty years in the complete destruction of Carthage.



VIEW ON THE SICILIAN COAST.

The town of Carthage was situated on the coast of Africa, directly south of Sicily. It was a colony of Phœnicians, whose home was in Syria, and whose chief towns were the great cities of Tyre and Sidon, so often mentioned in Scripture. The Phœnicians were the same people as the Canaanites, and long after they were driven out of Palestine by the Israelites, established for themselves a great maritime empire, the richest and most powerful of that time. They became the great carriers of the commerce of the countries round the Mediterranean, as the Venetians did in the middle ages, and planted many trading stations all over the coasts of Europe and Africa. They visited England, and carried away from Cornwall many a ton of tin centuries before a Roman had set foot in the island. They even penetrated into the Baltic, and brought thence amber to adorn the necks of the dark-eyed Southern women.

Carthage.

Carthage was one of these trading stations, founded about a century before Rome, and in time it became more powerful and richer than the mother country. At the period we have now reached, the greater part of the north coast of Africa had been conquered by her, and her fleets were supreme in the Mediterranean. Her government was an aristocracy, who had gained great wealth by trade. They had settlements in Sicily, and there they were constantly fighting against the Greeks, who for five or six hundred years had had colonies in the same island. But before the struggle for supremacy between the Greeks and Carthaginians in Sicily was decided, the Romans stepped in, and, as we shall see, conquered both. The wars against the Carthaginians were called by the Romans *Punic, i.e.* Phœnician wars. The first of these began in the year 264 B.C. Some Italian adventurers had seized the town of Messana, and, when attacked by the Carthaginians, sent to ask Rome to assist them. After a little hesitation on the part of the senate, the wishes of the people prevailed; a force was sent and in a short time the Romans were masters not only of Messana but of some sixty or seventy other Sicilian towns. By the end of the third year of the war the Carthaginians were almost driven out of the island; but at sea they were still supreme, the Romans having no navy as yet, and the coasts of Italy were much harassed.

First "Punic" war, B.C. 264.

But the Romans were not the people to acquiesce in this state of things. So they determined to have a navy. It is said they did not even know how to build a ship, until a Carthaginian war-vessel by good luck was wrecked and driven on their shores. With this as a model they soon built a large fleet, and, in order to lose no time in using it as soon as it should be built, they set to work to train sailors to row in long benches on dry land! Such energy as this was sure to succeed in the long run. But they were quite aware that sailors trained on dry land could hardly be a match for regular jack tars. So they hit upon the following device. In those days when there were no cannon, a sea-fight consisted of hand-to-hand struggles between the crews. The aim of the Romans was to board the enemies' ships as quickly as possible, and so they made long gangways, one end of which was fastened to their own ships, while the other, fitted with a sharp spike, could be lifted up and let fall on the enemies' deck. The two ships were thus locked together, and the Romans rushed by the gangway on board the enemy, and once on board they had little difficulty in overcoming the astonished Carthaginians. In this way the Romans gained two important victories at sea.

Rome builds a navy.

So strong were they now, that in 256 B.C. they sent an army to invade the Carthaginians in Africa. The consul Regulus was at first victorious, but at last his army was defeated and himself taken prisoner. He was sent to Rome to negotiate an exchange of prisoners, under a promise to come back if the senate would not agree to the Carthaginian proposals. Regulus delivered his message, but at the same time urged the senate not to agree. Acting on his advice the senate declined the offers of the Carthaginians, and Regulus, true to his promise, voluntarily returned to Carthage, leaving wife and family and country for his country's good, and was cruelly put to death there. Peace was made about five years after this, both sides wishing for a breathing space, but determined to renew the war as soon as possible. The Carthaginians gave up Sicily, which thus became the first Roman *province*. As time went on, Rome acquired many provinces. They were governed by a magistrate who was generally a Roman general. The people of these provinces had no share in the government of Rome and very little voice in their own government, but they were obliged to send money to Rome and supply men for the army. They were won by the sword and kept by the sword, and the people were treated harshly, as conquered nations generally were in those times.

Romans invade Africa.

"Roman provinces."

IV.

FRACTIONS.

WE know that if the numerator and denominator of a fraction be both multiplied or both divided by the same quantity, the value of the fraction is not changed.

Thus $\frac{a}{b}=\frac{ac}{bc}$; $a=\frac{ab}{b}$, for $a=\frac{a}{1}$. Multiply by b and we get $\frac{ab}{b}$.

$$\frac{ab+ac}{ad+ae}=\frac{a(b+c)}{a(d+e)}=\frac{b+c}{d+e}.$$

It follows that if the signs of all the terms in the numerator and of all those in the denominator of a fraction be changed, the value of the fraction is not changed; for this is equivalent to multiplying both numerator and denominator by the same quantity.

Thus $\frac{a}{b}=\frac{-a}{-b}$; $\frac{a-b}{b-c}=\frac{-a+b}{-b+c}=\frac{b-a}{c-b}$.

When both numerator and denominator contain a common factor, it is in most cases convenient to divide by this factor, and so simplify the fraction, just as it is more convenient to write $\frac{1}{2}$ than $\frac{4}{8}$. If we divide by the greatest common factor, we reduce the fraction to its lowest terms. This greatest, or better, highest, common factor is usually called the greatest common measure; and a special process is made use of to find it.

GREATEST COMMON MEASURE OR HIGHEST COMMON FACTOR.

The highest common factor of simple expressions is obtained by inspection simply.

Thus the H.C.F. of $3a^2bc$ and $5a^3b^2d$ is evidently at a^2b; and the H.C.F. of $10a+5ax$ and $5ab$ is $5a$.

When the H.C.F. of two multinomial expressions is required, set them down as for division, the one of highest dimensions being the dividend. Divide. If there be no remainder, the divisor itself is the H.C.F. If there be a remainder, divide the first divisor by it, and proceed until the terms are exhausted, making each successive remainder a divisor, and each divisor a dividend. Continue the operation until there is no remainder. The last divisor is the H.C.F.

Thus, to find the H.C.F. of x^3-49xy^3 and $x^5-2401xy^6$.

$$x^3-49xy^3)x^5-2401xy^6(x^2+49y^3$$
$$x^3-49x^3y^3$$
$$49x^3y^3-2401xy^6$$
$$49x^3y^3-2401xy^6$$

x^3-49xy^3 is the H.C.F.

Find the H.C.F. of y^4-y^2-72 and y^4-81.

$$y^4-y^2-72)y^4-81(1$$
$$y^4-y^2-72$$
$$y^2-9$$

Divide the first divisor by this remainder:

$$y^2-9)y^4-y^2-72(y^2+81$$
$$y^2-9y^2$$
$$8y^2-72$$
$$8y^2-72$$

y^2-9 is the H.C.F.

It is sometimes advisable, in order to avoid fractions in any of the quotients, to multiply or divide the divisor or dividend by some number or letter which will make the one a multiple of the other. This does not in any way change the result of the operation, so long as we do not multiply or divide by any factor common to both divisor and dividend. Thus, find the greatest common measure of $a^2-ab-2b^2$ and $a^2-3ab+2b^2$.

$$a^2-ab-2b^2)a^2-3ab+2b^2(1$$
$$a^2-ab-2b^2$$
$$-2ab+4b^2$$

Divide this remainder by $2b$ and change the signs—that is, multiply by -1.

$$a-2b)a^2-ab-2b^2(a+b$$
$$a-2ab$$
$$ab-2b^2$$
$$ab-2b^2$$

$a-b$ is the H.C.F.

To find the greatest common measure of three expressions, find the G.C.M. of two of them by the process thus described, and then find the G.C.M. of the third quantity and the G.C.M. of the first two.

Thus to find the G.C.M. of x^6-y^6, x^4-y^4, and x^3-y^3.

The G.C.M. of x^6-y^6 and x^4-y^4 is x^2-y^2.

The G.C.M. of x^3-y^3 and x^2-y^2 is $x-y$ and $x-y$ is therefore the G.C.M. of the three given expressions.

The G.C.M. of four expressions is found by taking the G.C.M. of one pair of them and the G.C.M. of the other pair, and then finding the G.C.M. of the two G.C.M.'s which are already found.

Examples.

Find the G.C.M. or H.C.F. of—

1. $a^3+a^2b-ab^2-b^3$ and $a^3b+2a^2b^2-ab^3-2b^4$. Ans. a^2-b^2.
2. a^6-b^6 and a^4-b^4. Ans. a^2-b^2.
3. a^4-b^4 and $a^3-a^2x-ax^2+x^3$. Ans. a^2-x^2.
4. $6a^2+7ax-3x^2$ and $6a^2+11ax+3x^2$. Ans. $2a+3x$.
5. a^8-b^8 and $a^{12}-b^{12}$. Ans. a^4-b^4.
6. $2x^3-6x+4$ and x^3-x^2-x+1. Ans. x^2-2x+1.
7. a^4-b^4 and a^7-b^7. Ans. $a-b$.
8. $3a^2x^{-3}-ab^mx^{-3}-4b^{2m}x^{-3}$ and $6a^2y^n-11ab^my^n+4b^{2m}y^n$. Ans. $+(3a-4b^m)$.
9. $x^2+2bx+b^2$ and x^3-b^2x. Ans. $x+b$.
10. $2x^3-16x-6$ and $3x^3-24x-9$. Ans. x^3-8x-3.
11. $2x^5+x^3+6x^2+3$ and $2x^5-2x^4-3x^3-3x^2-2x-1$. Ans. $2x^2+1$.
12. $84x^3+12x^2-21x-3$ and $308x-44x-77x+1$. Ans. $4x^2-1$.
13. $x^4+a^2x^2-2a^4$ and $x^4+ax^3-a^3x-a^4$. Ans. x^2-a^2.
14. $5a^5+10a^4b+5a^3b^2$ and $a^3b+2a^2b^2+2ab^3+b^4$. Ans. $a+b$.
15. $x^4+(a+1)x^3+ax^2$ and $x^4-(a-1)x^3-ax$. Ans. $x+1$.
16. $a^{2y}-b^{2y}$ and $a^{3y}-2a^yb^y+b^{2y}$. Ans. a^y-b^y.
17. $a^{n+1}-(a+2b)y^n+2a^nb$ and $a^{n+1}-(a+3b)y^n+3a^nb$. Ans. a^n-y^n.

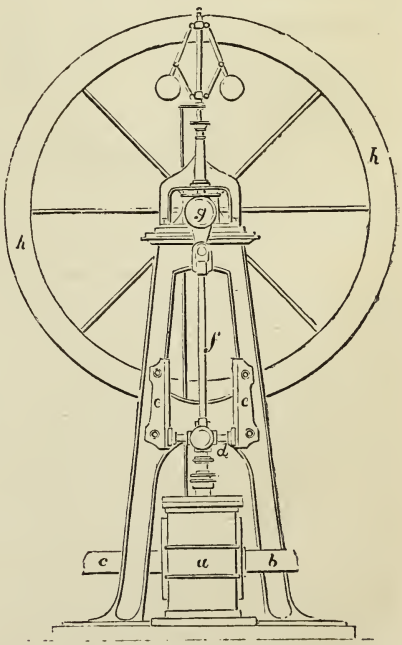


FIG. 4.—HIGH PRESSURE ENGINE (*see* page 656).

II.

The Steam Engine (*continued*).

Any one who has used a garden roller or pushed a hand-cart of any description will know that more force is necessary to start the motion than merely to continue it, and that the motion continues after the force has been withdrawn. The extra power used at starting is indeed stored up so long as the weighty apparatus is being moved, but the exact equivalent for this apparently wasted energy can be obtained at any time by leaving the apparatus to itself, as it is impossible for it to come to a standstill until it has given up every fraction of the power that it has absorbed. This capability that moving bodies have of absorbing energy is called *inertia*, and increases with their weight. To convert the series of jerks that the crank receives into a regular motion, it is only necessary to attach a heavy wheel, the *fly-wheel*, to the shaft connected with the crank. The fly-wheel is to the energy developed in the steam-engine exactly what the banker is to the merchant: it receives in times of plenty, and holds the surplus treasure until it is needed, when it is ready at an instant's notice to deliver up exactly that proportion that may be necessary to compensate for the failing supply.

The general arrangement of the more important parts of the steam engine is well shown in the accompanying view of a vertical high-pressure engine (*see* fig. 4, p. 655).

a is the cylinder, with its slide valve turned away from view, *b* the steam pipe leading from the boiler, *c* the exhaust pipe, *d* the piston-rod, fitted with a crosshead that works in the slides *e e*, *f* is the connecting rod, *g* the crank, foreshortened, *h h* the fly wheel.

The two balls represented at the top of the figure, which form so conspicuous a part of almost every steam engine, are a part of the *governor*, which regulates the speed of the engine, but in a totally different manner from the fly-wheel. As we have seen, the fly-wheel merely equalizes the motion, and is quite incapable of permanently increasing or decreasing it. The governor, on the contrary, is so arranged that it checks or augments the speed of the engine, when it gets too rapid or too slow, by decreasing or increasing the supply of steam from the boiler. This effect is ensured by causing the engine to rotate the upright shaft that the balls are suspended on. The more rapid the rotation, the further apart will the balls fly, and the separation of them raises the collar that is connected to them and slides on the governor spindle. The upward movement of this collar gradually closes the *throttle-valve* that is placed in the steam pipe leading from the boiler to the cylinder, so that an increase of speed is at once counterbalanced by a smaller supply of steam. The governor is especially useful in cases where the resistance to be overcome by the engine is subject to considerable and sudden alterations.

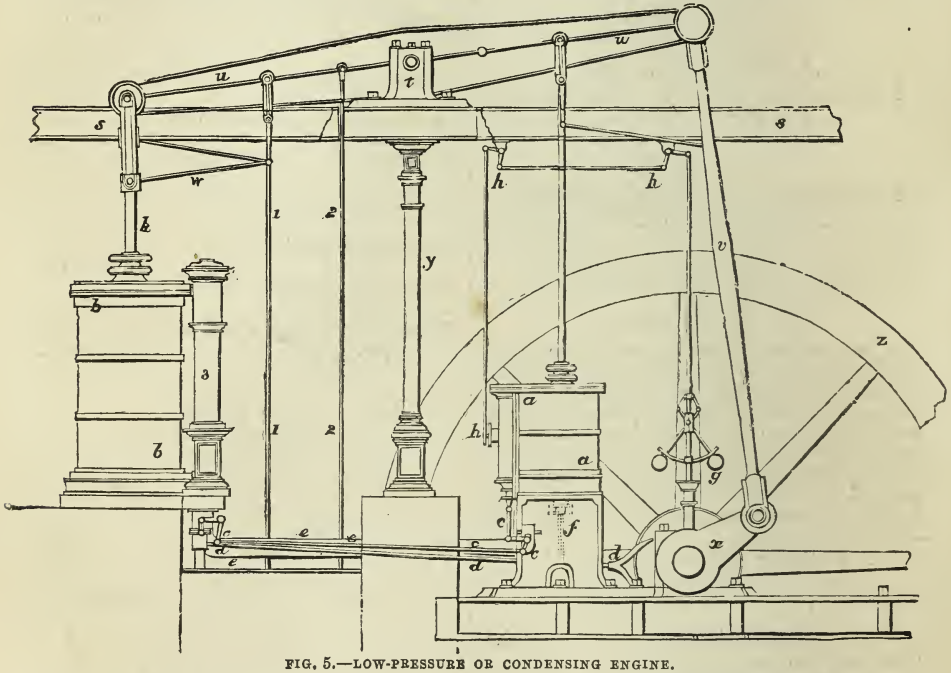


FIG. 5.—LOW-PRESSURE OR CONDENSING ENGINE.

Low-pressure or condensing engines are invariably of much greater dimensions than high-pressure engines, the greater size being necessary to compensate for the lower pressure and more moderate speed at which they work. The beam engine shown in fig. 5 may be considered a fair representative of this class. The cylinder is marked *b b*, *u u* is the beam, working on the pivot *t*, *x* is the crank, and *z* the fly-wheel. The rods numbered 1 and 2 on the left side of the beam work the pumps in connection with the condenser. The cylinder marked *a a* is an extra one, used in the particular engine from which this cut was engraved to increase its power when necessary.

The Locomotive.

The most superficial observer will, after a moment's reflection, be prepared to admit that the carriage of passengers and property from place to place forms one of the most important items of social life. The slightest improvement, therefore, in the means of transit is speedily appreciated by the public, and will certainly bring to the inventor or his supporters a reward bearing some proportion to the extent of its adoption.

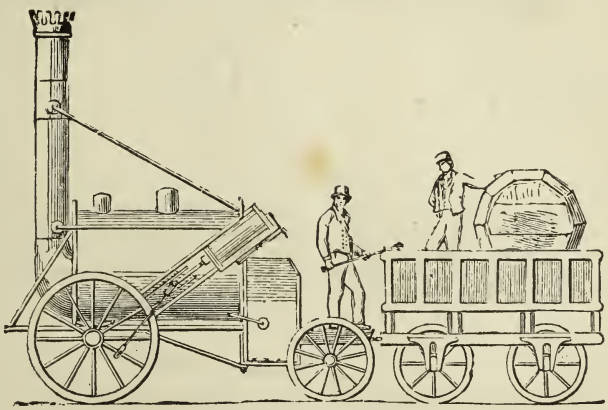


FIG. 6.—THE ROCKET.

Almost before the steam engine had shown signs of its vast power, the attention of those interested in it was directed to its application for the purposes of locomotion. As early as 1759, Robison suggested the possibility of driving carriages by steam power; and Watt, in his patent dated 1784, describes a method by which he proposed to construct an engine on wheels so that it could be caused to propel itself. A little later Watt's assistant, Murdoch, actually constructed a working model of a locomotive engine. In 1805 the locomotive constructed by Trevithick and Vivian was at work; but it should be noticed that in these and other early attempts, the importance of a railroad was not appreciated, for though some of the engines were constructed to run on rails, others were intended for use on the ordinary turnpike roads. It is the railroad, as we see it, that makes the present locomotive a possibility; for it would obviously be useless to construct an engine capable of moving at the rate of over sixty miles an hour, if there was not a road on which it could with safety attain such a speed. Our present railway system was developed from the most insignificant beginnings by George Stephenson. In 1829, the Liverpool and Manchester Railway was opened; and as the question whether the necessary motive power would be best obtained by the use of stationary engines or locomotives was brought forward, it was resolved by the directors to offer a prize of £500 for the best locomotive that should fulfil certain conditions. This prize was gained by Stephenson's engine, the "Rocket" (fig. 6), which had so many radical improvements that it may justly be described as "the parent of the swift and powerful locomotives of the present day."

The most prominent parts of the locomotive, and those that give rise to its well-known outline, are the more or less cylindrical boiler with the chimney at one end, and the frame-work which serves to support it upon the wheels. A closer inspection, however, will show that immediately under the boiler there are many mechanical contrivances with which we have become somewhat familiar in our study of the steam engine. But as the object of the machinery is to turn the wheels, it will be convenient to make a consideration of these our starting-point; then pass to what may be called the engine proper; and lastly, examine the boiler and fire-box with their numerous adjuncts.

A little more than fifty years ago it was a common notion among engineers, that for any locomotive engine running on rails to have the required drawing force, it would be necessary to prevent the wheels from merely slipping round on the rails by making the tires rough, fitting them with projecting bolts, or by securing toothed wheels by the side of those that bear the weight of the engine, to work in teeth provided for the purpose by the side of the rails. These devices were soon found to be not only unnecessary, but positive drawbacks. If the adhesion between one pair of wheels and the rails is not sufficient, as in engines for goods trains that have to draw heavy loads at only moderate speeds, it is usual to couple two or even three pairs of wheels together. It is important to notice that wheels coupled together must be of the same size. The *driving wheels* are those that are turned by the direct action of the engine, and are made as large as circumstances will allow, especially where speed is the chief object; as for a given number of turns the distance travelled is proportional to their circumference. They do not revolve on the axle, but are firmly secured to it, the axle being the crank-shaft of the engine. A representation of

this shaft, without the apparatus attached to it, is given in fig 7.

The two cranks are not placed as shown in the figure, but at right angles to each other; so that the dotted crank marked *d* would in a model stand up perpendicularly from the paper. These cranks are turned by a pair of cylinders with their pistons, piston-rods, connecting-rods, slide-valves, etc., constructed according to the description already given when speaking of the steam engine. It will be seen that this arrangement of the cranks secures a fairly uniform action of the engine, for when one is parallel with its piston-rod (that is, at either of its dead points), and therefore unable to receive any power from it, the other is at right angles to it and receiving its maximum impulse from the engine.

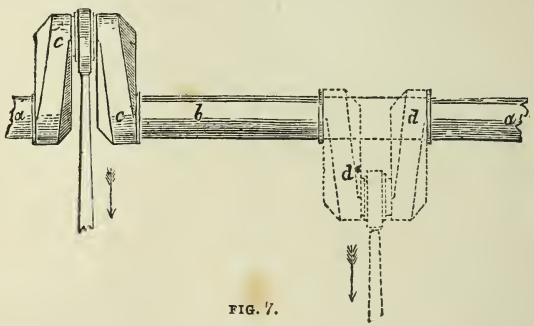


FIG. 7.

The reciprocating motion of the slide-valve is obtained in the locomotive, as in most stationary engines, by the ingenious contrivance known as the *eccentric*, a simple form of which is given in fig 8. Its action is exactly the reverse of that of the crank—namely, to convert a circular motion into a to-and-fro motion. This end is attained by fixing a grooved wheel on the crank-shaft in such a manner that the shaft passes, not through its centre, but considerably to one side of it. In the diagram, *a* shows the position of the crank-shaft, which is altogether to the left of the centre of the eccentric. This grooved wheel is surrounded by a rim in which it can revolve, *b b*, and to which are fixed the rods, *m*, *e*, to communicate motion to the slide-valve. It is obvious that as the shaft *a* revolves, the large part of the eccentric that is to its right in the figure will gradually be brought to an opposite position, and that then the rods connected with the rim *b b* will be pushed towards the left. In order to be able to reverse the engine at pleasure, each slide-valve has two eccentrics, one for the forward and the other for the backward motion, and these are so arranged that the slide-valve can be put into connection with either by the simple action of a lever.

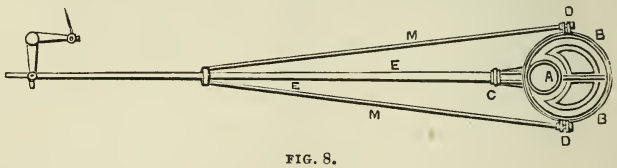


FIG. 8.

In many locomotives the cylinders are placed outside instead of between the wheels, the connecting-rod being attached to a pin projecting from the wheel itself. This arrangement has certain advantages; but it may be taken as a general rule that the nearer the cylinders are to the boiler the better.

FRENCH GRAMMAR.

XL.

THE VERB (*continued*).—THEORY.

1. THE VARIOUS CLASSES OF VERBS.—The distinguishing features of the five classes of *attributive* verbs have been given in vol. i., p. 591. A comparative study of these classes with the corresponding ones in English remains to be made.

I. THE ACTIVE TRANSITIVE VERB may always have a direct object. It is conjugated with *avoir*, the auxiliary indicative of *action*, and its past participle agrees only when the direct object precedes the verb. *Ils ont amassé des richesses*, they have gathered riches. *ont amassé* is an active transitive verb because it has a direct object, *richesses;* it is conjugated with *avoir* because it expresses an action; and the past participle remains unchanged because the direct object, *richesses*, is placed after the verb. *Ils les* (*les* standing for *richesses*) *ont amassées*, they have gathered them: agreement of *amassé* with *les*, fem. plur., direct object placed before the verb.

Many active verbs in French are likewise active in English. Here follow some of the more important exceptions under a three fold classification:

a. Verbs strictly transitive in French and intransitive in English, in some or all of their acceptations:—

accepter—*to accept of the terms* (Webster), a. les termes.
admettre—*to admit of the difficulty*, a. la difficulté.
approuver—*to approve of the measure* (W.), a. la mesure.
attendre—*to wait for the coach*, attendre la voiture.
chercher—*to look for a rope*, chercher une corde.
demander—*to ask for a thing*, demander une chose.
désirer—*to wish for a husband*, désirer un mari.
écouter—*to listen to one's wife*, écouter sa femme,
endurer—*to bear with ignominy*, endurer l'ignominie.
payer—*to pay for a dinner*, payer un dîner.
prier—*to beg of one's friends to . . .*, prier ses amis de.
regarder—*to look upon an illness as . . .*, regarder une maladie comme.
remettre—*to put off an entertainment*, remettre une fête.
rencontrer—*to meet with perils*, rencontrer des dangers.
résoudre—*to resolve upon war*, résoudre la guerre.
souhaiter—*to wish for health*, souhaiter la santé.

b. Verbs strictly transitive in English, but governing an indirect object by *à* in French:

to allow—permettre à ses enfants, *to allow one's children.*
to answer—répondre aux lettres, *to answer letters.*
to attempt—attenter à la vie, *to attempt the life.*
to concern—importer à l état, *to concern the State.*
to forbid—défendre aux gens, *to forbid people.*
to forgive—pardonner aux pécheurs, *to forgive the sinners.*
to obey—obéir aux lois, *to obey the laws.*
to order—ordonner au cocher, *to order the coachman.*
to persuade—persuader au monde, *to persuade the world.*
to renounce—renoncer au vin, *to renounce wine.*
to reproach—reprocher sa conduite à quelqu'un, *to reproach some one with his conduct.*
to resist—résister aux tentations, *to resist temptations.*
to resemble—ressembler à un singe, *to resemble a monkey.*
to succeed—succéder à son aïeul, *to s. one's grandfather.*
to suit—cela leur convient, *that suits them.*
to touch—il touche à tout, *he touches everything.*

c. Verbs strictly transitive in English, but governing an indirect object by *de* in French :

to change—changer de sujet, *to change a subject.*
to disown—disconvenir d'une chose, *to disown a thing.*
to doubt—douter de la véracité, *to doubt the truthfulness.*
to enjoy—jouir de la vie, *to enjoy life.*
to lament—j'en (*v.* p. 200, *e*) gémis, *I lament it.*
to lack—manquer de tout, *to lack everything.*
to strike—heurter de la tête, *to strike the head.*

II. The Active Intransitive Verb conforms to the conjugation of the active transitive verb, with the exception that out of about six hundred intransitive verbs found in French a few over forty take, or may take, *être* in their compound tenses. The past participle of those which take *être* agrees in gender and number with the subject : *il était* mort *dans les bras de sa femme*, he had died in his wife's arms ; *elle était* morte *de sa belle mort*, she had died a natural death. The past participle of those intransitive verbs which require *avoir* cannot change, there being no direct object.

a. The most important of those using *être* will be found among the irregular verbs : *aller*, to go ; *partir*, to depart ; *mourir*, to die ; *venir*, to come ; *naître*, to be born ; *choir*, to fall ; *éclore*, to be hatched ; and their derivatives. Add the following, which are regular :

arriver, *to arrive.*	tomber, *to fall.*
décéder, *to die.*	retomber, *to fall back.*
rentrer, *to re-enter.*	retourner, *to go back.*

b. The following verbs are conjugated with *avoir* when the *action* is considered, and *être* when one has in view the *result* of the action, transformed then into a *state : Elle* a monté *trois fois à sa chambre dans un quart d'heure*, she has gone up three times to her room in a quarter of an hour ; *elle* est montée *à sa chambre*, she is gone up to her room. *La fièvre* a cessé, the fever has ceased (for the nonce, but may return : to stop in order to begin again constitutes here the action) ; *la fièvre* est cessée, the fever is ceased (for good—it is not likely to return—things will remain as they are : this constitutes a state).

aborder, *to land.*	échapper, *to escape.*
accourir, *to run to.*	embellir, *to embellish.*
accroître, *to increase.*	empirer, *to grow worse.*
apparaître, *to appear.*	entrer, *to enter.*
cesser, *to cease.*	grandir, *to grow.*
changer, *to change.*	monter, *to go up.*
croître, *to grow.*	partir, *to set out.*
déborder, *to overflow.*	passer, *to pass.*
demeurer, *to remain.*	rajeunir, *to grow young again.*
déchoir, *to decay.*	rester, *to remain.*
descendre, *to descend.*	remonter, *to go up again.*
disparaître, *to disappear.*	vieillir, *to grow old.*

c. Besides presenting the double view of *action* and *state*, a change of auxiliary brings about in several cases a modification of sense. This will be explained in a special article upon the auxiliaries.

Certain intransitive verbs are sometimes used transitively with a new acceptation ; they then can take no auxiliary but *avoir*, and obtain a direct object : *nous* avons rentré *nos foins*, we have brought in our hay ; *voici les foins que nous avons* rentrés (see I.), this is the hay which we have brought in.

III. The Passive Verb is formed by joining to *être* the past participle of the active transitive verb, the past participle being made to agree with the subject. The direct object of the active transitive verb becomes the subject of the passive : *la loi protège les citoyens*, the law protects the citizens ; *les citoyens sont protégés par la loi ; les citoyens* direct object to *protège* has become the subject to *sont protégés ;* and *protégés* agrees in gender and number with its subject, which is masculine plural.

From this it follows that none but active transitive verbs can be turned into passives ; and that is indeed the case, with the exception of *être obéi, être pardonné, être convenu*, which come from the intransitive verbs *obéir à*, to obey ; *pardonner à*, to forgive ; *convenir de*, to agree.

Passive verbs are comparatively little used in French. This constitutes one of the most important points of dissimilarity between the two languages. It will be developed only gradually here.

2. Points of Difference in the Use of the Possessive Pronouns in French and English.

a. Idiomatic illustrations of rules already given at p. 563.

Les yeux lui sortaient de la tête, *her eyes were starting from her head.*
Vous avez un rhume de cerveau, *you have a cold in your head ;* un rhume de poitrine = *a chest cold.*
L'assassin s'est brûlé la cervelle, *the murderer blew his* (own) *brains out ;* l'assassin lui brûla la cervelle, *the murderer blew his* (another man's) *brains out.*
Vous essayez de nous jeter de la poudre aux yeux, *you attempt to throw dust into our eyes*, jeter de la poudre aux yeux des gens, *to throw dust into people's eyes.*
La lumière leur fait mal aux yeux, *the light hurts their eyes.*
Avoir un mot sur le bout de la langue, *to have a word at the tip of one's tongue.*
L'eau vous en vient à la bouche, *one's mouth waters at it ;* vous nous faites venir l'eau à la bouche, *you make our mouths water.*
Ces huîtres m'ont ouvert l'appétit, *these oysters have sharpened my appetite.*
Je vous frotterai les oreilles, *I will box your ears*, elle m'a tiré l'oreille, *she has pulled my ear.*
Ils avaient des cloches aux pieds, *they had blistered feet ;* j'ai des ampoules (*or* cloches) aux mains, *I have blistered hands.*
Le courage te manque, *thy courage fails thee ;* le courage te revient, *thy courage returns.*
Elle m'a monté la tête contre mes parents, *she has prejudiced my mind against my relations.*
Prendre quelqu'un au mot, *to take some one at his word ;* je vous prends au mot, *I take you at your word.*
On nous ramena à la raison, *we were brought back to our senses.*

b. How to render the English possessive pronouns after the verb *to be.* This is generally done by *à*, followed by the personal pronoun in the disjunctive form :

Whose is it (the object not being named)? It is mine it is thine, it is his, it is hers = *à qui est-ce ? c'est à moi, c'est à toi, c'est à lui, c'est à elle.*

I found a button: whose is it? it is mine, it is thine. I found a hook: whose is it? is it yours? is it hers? = *J'ai trouvé un bouton; à qui est-il? il est à moi, il est à toi. J'ai trouvé une agrafe; à qui est-elle? est-elle à vous? est-elle à elle?*

Whose boot-lace is this? it is mine = *à qui est ce lacet? il est à moi,* or *c'est à moi,* or *c'est le mien.* The last form, being the most emphatic, would be more particularly found in a counter assertion, etc.: No, it is not thine, it is Mary's = *non, ce n'est pas le tien, c'est celui de Marie.*

But in connection, although not exclusively, with abstractions, *mine, thine,* etc., are rendered after *être,* by *mien, tienne,* etc., with disappearance of the article. This construction is found more frequently in the old authors than in the modern:

Ses intérêts sont miens (Rotrou, 1609—1650), *his interests are mine.*

La belle Oranthe sera tienne (Malherbe, 1555—1628), *beautiful O. shall be thine.*

Ainsi ce rang est sien, cette faveur est sienne, et je n'ai rien enfin que d'elle je ne tienne (Corneille, 1606—1684), *so this dignity is hers, this interest is hers; in short, I possess nothing but what I hold* (tienne, *from* tenir, *to hold*) *from her.*

Arnauld prétend que la doctrine de Malebranche n'est ni nouvelle ni sienne (Diderot, 1713—1784), *A. maintains that M.'s system is neither new nor his own.*

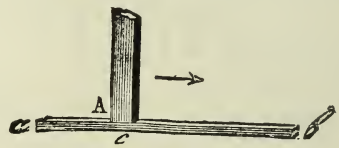


FIG. 71.—SINGLE TOUCH.

Remark.—Those forms appear without the article in connection with other verbs than *être: Mais surtout fais si bien, qu'elle garde toujours l'ardeur de me voir sien* (Molière, 1622—1673), but, above all, manage matters so well that she may ever cherish the ardour of seeing me her own; *le conseil de Trente reconnaissait bien que les mérites de Jésus-Christ et de sa passion étaient rendus nôtres par la justification* (Bossuet, 1627—1704), the council of Trent was indeed recognising that the merits of Jesus Christ and His passion had become ours by justification. [We light upon (Littré, vol. iii., p. 752) a curious construction taken from Molière: *Et n'appréhendez plus l'interruption nôtre,* fear no more any interruption of mine. This, which is a transcript from the Italian (*è in casa il fratello vostro?*), is no longer admissible.]

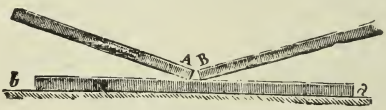


FIG. 72.—DOUBLE TOUCH.

c. How to render *a . . . of mine, a . . . of thine,* etc., after a noun. This familiar construction is, in the majority of cases, rendered by *un de mes . . . , une de mes . . . , un de tes . . . , une de tes . . . ,* putting the noun last:

J'ai vu les lettres que vous débitez contre celles que j'ai écrites à UN DE MES AMIS sur le sujet de votre morale (Pascal), *I read the letters which you indite* (*retail*) *against those which I wrote to* a friend of mine *on* (*the matter of*) *your ethics.*

A construction, which in quaintness exactly corresponds to the English *a . . . of mine,* etc., is *un mien . . . , une mienne . . . , un tien . . . ,* etc.:

Au travers d'UN MIEN pré certain ânon passa (Racine), *through* a *pasture* of mine *a certain ass-colt wound its way.*

Vous prétendez avoir recours à QUELQUE MIENNE rhapsodie (Voltaire), *you claim to take the assistance of* some *rhapsody* of mine.

This does not extend to *le nôtre, le vôtre, le leur,* nor to the plural of *le mien, le tien, le sien;* one could not therefore render *a cousin of ours, friends of mine,* by *un nôtre cousin, de miens amis,* but by *un cousin* à nous, *des amis* à moi; see *b.*

Various idiomatic renderings of *a . . . of mine, that . . . of mine,* etc.:

Et d'abord, vous prenant pour CE MIEN camarade, mes sens d'aise aveuglés ont fait cette escapade (Corneille), *and, at first, blinded by pleasure, my senses, taking you for* that *comrade* of mine, *committed this blunder.*

Il y a longtemps que nous n'avons eu DE SES lettres, *it is a long time we have had* a *letter* of his (*or* of hers).

Ce sont DE VOS créanciers, DE VOS amis, DE VOS tours, *those are creditors* of yours, *friends* of yours, *tricks* of yours.

Où DONC est MON chapeau? *where is that hat of mine?*

Que sont DONC devenues vos bottines, Qu'est-ce donc qu'on a fait de vos bottines? *what has become of those boots of yours?*

Que voulez-vous me donner de MON cheval QUE VOILÀ? *what will you give me for* this *horse* of mine?

Plus tard vous êtes venu à Paris avec UN frère QUE VOUS AVEZ, *later on you came to Paris with* a *brother* of yours.

De quoi vous mêlez-vous? cela ne VOUS REGARDE pas, *what are you meddling with? it is no* business of yours.

d. Cases of the present participle preceded by the possessive do not exist in the French language:

On my taking leave = quand je pris congé (*when I took leave*).

She took offence at his refusing to go with her = elle s'est offensée de ce qu'il it refusé de l'accompagner.

On his finding out the truth, he collapsed = lorsqu'il découvrit la vérité, il s'affaissa.

Thanks to her talent for fault-finding = grâce au talent qu'elle possède de trouver à redire à tout.

How were you pleased with his teasing you in such a manner? = comment avez-vous trouvé sa manière de vous taquiner?

Your speaking to her will make no difference = que vous lui parliez ou non, cela ne servira à rien.

[A double list of idioms illustrating differences in the use of the possessive pronouns is reserved for next lesson.]

XXI.

MAGNETISM (*continued*).

AMONGST the most simple methods by which magnetic properties may be imparted to steel bars, so as to convert them into artificial magnets, will be found the following:— **Methods of magnetisation.**

1. Let one extremity of the steel bar be brought into contact with one pole, say the

north, of a permanent magnet, and let it remain there for some little time. Upon removing it, it will be found to possess magnetic properties, the end which was in contact with the north pole of the magnet being a south pole.

2. Draw repeatedly one end of the steel bar in the same direction across the north pole of a permanent magnet, and then draw the other extremity of the bar across the south pole of the magnet. The bar will be magnetised, its former end being a south, its latter a north pole.

3. Lay the bar across the poles of a horse-shoe magnet and let it remain for a few moments. Upon removing it, it will be found to be magnetised, each end having an opposite polarity to that of the magnetic pole with which it was in contact.

4. The most common and most ancient method of magnetising a steel bar is by the method known as that of *single touch*. This is represented in fig. 71, on the opposite page.

Single touch.

Here one pole of the magnet is placed in the middle of the bar to be magnetised, and is then drawn to the end of the bar. The magnet is then returned through the air to the middle of the bar and the same process is repeated. After this has been done several times, the other pole of the magnet is taken and placed on the middle of the bar as before, and is then drawn to the other end of the bar. This is done several times, and at length the bar becomes thoroughly magnetised, its ends having the opposite polarity to that of the pole of the magnet with which they were respectively magnetised.

5. A more efficient method of magnetising steel bars is that known as *double touch*. Here, as shown in fig. 72, opposite, the bar to be magnetised, *a b*, is laid flat upon a table, and two magnets, A B, with their two dissimilar poles opposite, but not touching each other, are placed in the middle of the bar. They are then drawn in opposite directions to the ends of the bar; are then returned through the air to the middle of the bar, and the process being several times repeated the bar becomes permanently magnetised.

Double touch.

A modification of this method is shown below, in fig. 73.

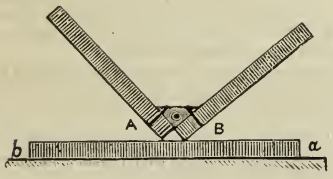


FIG. 73.

Here the two dissimilar poles of the two magnets are tied together with a small piece of card or wood between them, and starting as before at the middle of the bar, the magnets are first drawn along the bar to one of its ends. They are next carried through the air to the other end of the bar, and then drawn along its whole length. This process is repeated several times on both sides of the magnet, care being taken to leave off in the middle. In all these processes of magnetisation the same principle is employed: the poles of the magnet employed separate the magnetic fluids of the neutral bar, attract the opposite kind of polarity to themselves, and repel that of the same kind as their own.

With all methods of magnetisation, there is found to be a limit to the intensity of the magnetism which a given bar of steel will accept, and when this limit is reached the bar is said to be *saturated*. Although, as we have previously observed, steel retains its magnetism for a very lengthened period, that period is not unlimited, and there is noticeable a distinct deterioration in the magnetic properties of a steel bar which has been magnetised, if it is kept for a considerable length of time. The enfeeblement of permanent magnets may to a great extent be prevented by attaching to their poles a piece of soft iron, which is commonly known as the *armature* or *keeper* of the magnet.

Saturation of magnets.

It is not always necessary to employ a magnet to induce magnetic properties in soft iron or even steel. A simple experiment by which this fact may be exemplified is shown in fig. 74.

Magnetisation without magnets.

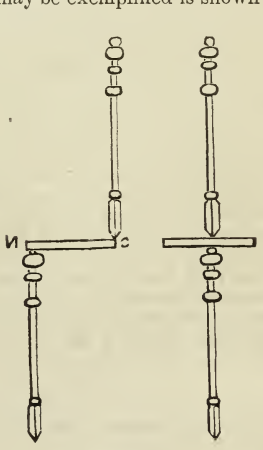


FIG. 74.

Let a common sewing needle be fixed in the magnetic meridian against a table. Then take two pokers and place one above and the other below the middle of the needle as represented in the figure. Then move the pokers in different directions towards the ends of the needle, and repeat the operation several times; it will be found that the needle has become magnetised. The explanation of this curious result is that the mere fact of placing the pokers in the direction of the magnetic dip converts them into temporary magnets. For the same reason pokers and other metal bars which have been by accident allowed to stand vertically so as to be in the direction of the

magnetic dip, frequently exhibit feeble magnetic properties.

We have now given a general *resumé* of the facts of magnetism proper; and the further elucidation of these facts, together with the theories by which they may be explained, will be treated of under the head of "Electro-magnetism."

Electro-magnetism.

Having made ourselves acquainted with the phenomena of ordinary magnetism, we are now in a position to take up that branch of electrical science which treats of the connection between electricity and magnetism, and which is usually known as *electro-magnetism*.

We have already seen that when the metallic plates of an ordinary Voltaic cell are connected by a wire, the latter, during the passage of a current, has the power of attracting iron filings, and so resembles a magnet. Moreover, we have seen further that if a current is passed through a coil of wire in which a steel bar is lying the latter becomes magnetised; and we have also seen that when a freely suspended magnetic needle is brought near a wire through which a current is passing, the needle is deflected from its normal position.

Magnetism by electricity.

These facts all tend to show that there is a direct connection between the electrical and magnetic conditions, and this is more fully shown when we introduce an iron bar into the voltaic circuit. If we take a battery wire, which is uncovered, and wind it round a bar of soft iron, the latter becomes a part of the circuit. If, however, the wire is insulated, as is ordinarily done by covering it with cotton or silk, the wire may be wound round the bar of soft iron without coming into contact with it. Nevertheless, although not in the circuit, the bar will exhibit very powerful magnetic properties, and the strength of its magnetism will be increased with the increase of the number of coils of the wire which surrounds it. By making these coils very numerous a temporary magnet of enormous strength may be obtained, vastly exceeding in power any of the steel permanent magnets of which we have recently been speaking. Such a magnet is termed an *electro-magnet*, and is usually made in the form of a horseshoe and provided with a strong soft iron *armature*. The covered wire is generally coiled round a hollow reel, and forms an *electro-magnetic helix*. In this the soft iron bar, which is termed the *core*, is placed.

Electro-magnets.

Immediately a current passes through the wire surrounding the core, the latter becomes a powerful magnet. When the current is broken the magnetism of the core almost instantly disappears.

Although a core greatly intensifies the power of an electro-magnet, it is not indispensable. A helix without a core will, when a current is passing through it, exhibit magnetic properties; it has two poles, with a magnetic equator between, it attracts iron and other magnetic substances, and will, if free to move, set itself in the magnetic meridian. When, however, a helix and core are employed together, the strength of the combination is much greater than that of the helix alone.

In fig. 75, an electro-magnet of the ordinary form is represented. M is the horseshoe-shaped soft iron bar or core, P N are the ends of the helix of covered copper wire, K is the soft iron armature, the ring at the bottom of which is employed to attach any weights or other

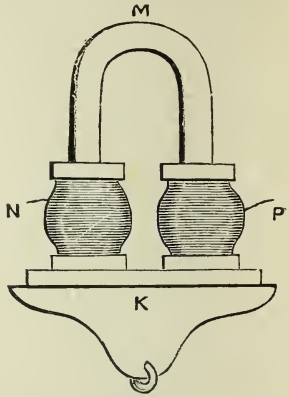


FIG. 75.

bodies which it is desired to suspend from it.

Law of electro-magnetic attraction.

The law which governs the attraction of electro-magnets is one which requires careful attention in order that its import may be thoroughly understood. If the attraction of a certain electro-magnet upon a piece of soft iron be taken as 1, upon doubling the strength of the magnet the attraction between it and the iron will not be 2, but 4. In the same way, if the strength of the magnet be trebled the attraction will not be 3, but 9. That is to say, the attraction of the magnet upon soft iron is proportioned not simply to the strength, but to the *square of the strength* of the magnet.

Difference between iron and steel.

If, however, the substance acted upon by the electro-magnet is hard steel, and not soft iron, the attraction is proportional simply to the strength of the magnet. That is to say, double the strength, and the attractive force is doubled; quadruple the strength of the magnet, and the attractive force is quadrupled.

Reason of the difference.

To make the reason of this difference clear, we must remind our readers of what has been already said in the papers on magnetism with regard to the difference between soft iron and hard steel in the reception of magnetic properties.

It will be remembered that whereas soft iron accepts magnetisation with extreme readiness, hard steel is only magnetised with difficulty; this resistance which steel offers to the reception of the magnetic condition being termed *coercive force*. It is this coercive force which is at the bottom of the difference just referred to.

Now, when a piece of soft iron is placed near

an electro-magnet, it is immediately converted into a temporary magnet, so that we have not merely a magnet attracting a magnetic substance, but two magnets attracting each other, and every increase in the strength of one is followed by an increase in the strength of the other. Suppose, for instance, an electro-magnet has one imaginary unit of magnetism; that one unit will evoke in the soft iron one unit of magnetism, and the attraction of the magnet and the iron will therefore be 1. If, however, the strength of the magnet is so increased that it possesses two units of magnetism, each of those units will evoke a unit of magnetism in the soft iron, and the pull between the two bodies will now be $2 \times 2 = 4$. In the same way, if three units of magnetism are given to the electro-magnet, three units will be induced in the soft iron, and the total attraction will be $3 \times 3 = 9$, and so on. In this way it is easy to see how the attraction between soft iron and an electro-magnet is proportional to the *square* of the magnet's strength.

On the other hand, when an electro-magnet attracts hard steel, no magnetism is induced in the latter, and consequently any increase in the power of the magnet produces no corresponding increase in the attraction of the steel upon it, and therefore when an electro-magnet acts upon hard steel the attractive force increases simply *as the strength*, and not as the square of the strength, of the magnet.

Diamagnetism.

A very curious property possessed by certain substances, called diamagnetism, may be more clearly shown by an electro-magnet than by an ordinary steel magnet.

The property in question is that of *repelling* the poles of a magnet, and being repelled by them, and is possessed by the metals antimony and bismuth in the most marked degree. The repulsion due to diamagnetism is, however, vastly feebler than the attraction due to the force of magnetism.

So far back as 1778 the repulsion of bismuth by a magnet was known. The repulsion of antimony was first observed in 1827. In 1845 Faraday showed that all matter could be divided into two kinds—that which was *attracted* and that which was *repelled* by the poles of a magnet, and to the force of repulsion he gave the name of *diamagnetism*.

Law of diamagnetic repulsion.

Upon examination it is found that the repulsion of a diamagnetic substance by a magnet follows the same law as that which governs the attraction of soft iron by an electro-magnet; that is to say, it is proportional to the square of the strength of the magnet. It is, therefore, obvious that diamagnetism is induced in the substance by the influence of the magnet.

Comparison of intensities of magnetism and diamagnetism.

Of all diamagnetic substances bismuth is most strongly repelled by the poles of a magnet; but it has been calculated that the magnetism of a thin bar of iron exceeds the diamagnetism of a similar mass of bismuth about two and a half million times.

XLVII.

The Rule of Louis XIV.

Long reign of Louis XIV

For many reasons the long rule of the magnificent prince to whom the adulation of his contemporaries accorded the title of "the Great" is the most important in history. Its enormous duration, extending over more than the threescore-and-ten years allotted to the life of man; the tremendous power concentrated in the hands of one man, without such counteracting influences as checked the power even of potentates like Charles V. of Germany; the great blaze of military glory that lighted up one portion of the period of Louis XIV., and the eclipse and thick darkness of its closing years, all render this reign memorable; and in the tendency of the sway of Louis XIV. we can already see the foreshadowing of the tremendous outbreak that was to shatter the French monarchy to pieces three quarters of a century after the death of the "Grand Monarque," whose greatness, evinced principally in rapacious ambition and warlike aggression, was destined to cost his country dear.

Completion of the despotic system.

The great feature of the reign of Louis is the concentration of the whole authority of the government in the hands of the king. In the time of his predecessor, and during his own minority, it was the prime ministers, the two great cardinals Richelieu and Mazarin, who successively ruled France. But Louis XIV., though he was excellently well served by a number of distinguished men, had no prime minister. Such an arrangement would not have accorded with the all-absorbing ambition of a monarch, whose oft quoted assertion, "*L'état c'est moi*"—"I am the state," sufficiently indicates the nature of his rule.

The little king was not five years old when his father died at the age of forty-two. By his testament, Louis XIII. had left his son in the guardianship of the widowed queen Anne of Austria, who was to be regent, assisted by a council, whose votes were to decide public questions. But the queen was entirely influenced by Cardinal Mazarin, the friend and pupil of the lately deceased Richelieu; and Mazarin induced the parliament of Paris to supersede the late king's will by abolishing the council and giving the sole authority as regent to the queen. Mazarin had even a more complete sway over Anne of Austria than Richelieu had held over Louis XIII.

Condé and Turenne.

The first period of the regency is memorable for the victories of two men whose names occupy a proud place on the roll of French military commanders—the Duc d'Enghien, afterwards known as "the great Condé," who,

at the age of twenty-one, approved himself ripe for military command; and the Vicomte de Turenne, his worthy rival and competitor in the race for warlike fame. The great and ruinous struggle of the Thirty Years' War was approaching its close in Germany; and in that struggle Richelieu had interfered actively, not for the maintenance of the Catholic religion, but for the humiliation of the house of Austria; to procure which he had aided the Protestant princes with men and money. It was at this period that the victories were gained on which the reputation of Condé, and in a minor degree that of Turenne, was based—Rocroy, Fribourg, and Nordlingen, won respectively in 1643, '44, and '45. The three treaties—that of Westphalia in 1648, of the Pyrenees in 1659, and of Oliva in 1660—though they did not thoroughly deal with all the questions at issue, were yet in general welcome to all the contracting parties as putting an end to a long period of strife and bloodshed, and ushering in what was expected to be a time of peace and tranquillity to the nations of Europe.

ANTWERP FROM A CROSS ROAD.

Not many months after the treaty of the Pyrenees and the marriage of the young king to the Infanta Maria Theresa of Spain, Cardinal Mazarin died, like his predecessor Richelieu, in the plenitude of his power, having triumphed over all his enemies and lived to see his various schemes crowned with success. He had swayed the destinies of France for nearly twenty years; for though some three years of that time had been passed in exile, his influence had continued unbroken. He left an enormous fortune, and a superb collection of diamonds, which latter he bequeathed to the crown. To the question, to whom the officials were to apply for the instructions they had been accustomed to receive from the cardinal, the king replied, "To me." From that time forward he had no prime minister.

Death of Mazarin; Louis rules alone.

The despotic character of Louis soon manifested itself; and Europe became convinced that a tyrant of the haughtiest temper had grasped the reins of government in France. At this period of his life Louis appears in the various portraits and descriptions that have descended to our time as a man of a handsome countenance, well-shaped mouth, aquiline nose, piercing blue eyes, and a cold, proud expression of face; somewhat slow and deliberate of speech, as if wishing to give impressiveness to every word he uttered; adding to his somewhat low stature by wearing red heels of inordinate height to his shoes. He was strong and hardy in constitution, and a lover of the chase; fond of magnificence, and intensely punctilious in matters of etiquette and ceremony; with unbounded confidence in himself, and a selfishness that disregarded all right and justice where his interests were concerned.

Appearance and character of the king.

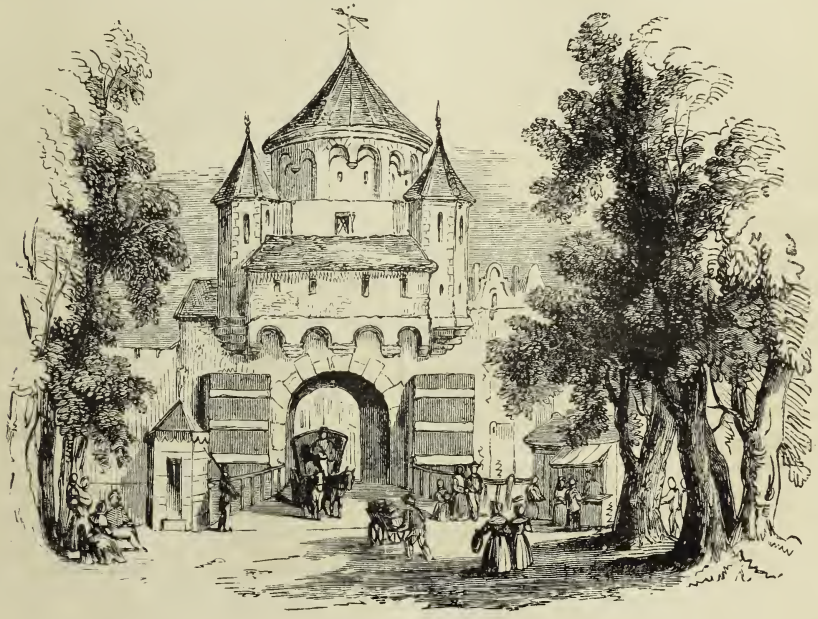
The Superintendent of the Finances, Fouquet, fell under the king's displeasure. The magnificence displayed in his surroundings, and the enormous fortune he was known to have amassed, roused the suspicion and jealousy of the king, whose displeasure was not appeased by a fête of unexampled gorgeousness given by the minister in his honour at his splendid house of Vaux, on which entertainment he is said to have spent £40,000. Shortly afterwards Fouquet was arrested on various charges of malversation of public

Trial and condemnation of Fouquet.

funds, extortion, and fraud; and after a lengthened trial was condemned to perpetual imprisonment, with forfeiture of his goods and chattels to the king. To the great advantage of the nation he was succeeded as Controller-General of Finances, though the office of Superintendent was abolished, by Colbert, who had been formerly employed by Mazarin, and who proved to be one of the ablest and most honest servants the crown of France has ever employed; understanding the real springs of the wealth of France, and managing her resources, and developing her trade and manufacture to high prosperity.

Colbert.

It would have been well for Louis if he had guided himself by the principles of Colbert. But he was naturally far too fond of pomp and display; and even one of his eulogists says of him, "He possessed sagacity of mind,



GATE AT HAARLEM.

but had such a great opinion of himself that he was little swayed by counsels." Already at this period of his reign he launched into that system of profuse expenditure and magnificence afterwards illustrated in the enormous buildings, the cascades and alleys, the gardens and plantations of Versailles. and in the fêtes and entertainments, by which the monarch dazzled and captivated a servile nobility and court.

Versailles and its fêtes.

The despotic temper of Louis was soon manifested in his transactions with foreign powers. A quarrel in London for precedence between the servants of the French and of the Spanish embassies gave Louis an opportunity of humiliating his father-in-law, Philip IV. of Spain, who was compelled to send the Count de Fuentes with apologies, and promises that cause of offence for the future should be avoided. A broil, such as not unfrequently occurred in those days, between the Pope's Corsican guard in Rome and some attendants of the Duc de Créqui, the French ambassador, was made the pretext for the seizure of the papal territory of Avignon by the king, who threatened an invasion of Italy, and was only appeased by the arrival of a legate from Rome with ample apologies and guarantees against the recurrence of such an incident; the quarrel and the satisfaction demanded being by express stipulation recorded on a monument erected in Rome at the spot where the disturbance had happened.

Arrogance of Louis.

Aggressive ambition was a strong trait in the character of Louis; and to this was joined the faculty of long and patient waiting till an opportunity came for carrying out his designs. During some years he was occupied in increasing his army, and strengthening the fortifications which guarded France on the frontier of Flanders; for which purpose it was that he purchased from the needy and unscrupulous Charles II. of England the fortress of Dunkirk, ceded to the English as the price of British valour at the treaty of the Pyrenees. His warlike preparations were all complete when the death of Philip IV. of Spain, who was succeeded by Charles II., his young and weakly son by a second marriage, gave him the opportunity he desired. By his marriage treaty, in consideration of a dowry of half a million of crowns, Louis had agreed to the stipulation that the infanta should give up all claim to inheritance of her father's territories; now, however, he

War with Spain, 1667.

set up claims to Brabant, Flanders, and Franche Comté. In 1667 he suddenly invaded Flanders. The campaign had been excellently prepared by the war minister, Louvois; while the great Turenne was at the head of the attacking army; and Vauban, the inventor of a new system of fortification, was present to put into a state of defence the towns that should be taken.

The march of the French army was almost an unbroken triumph. Lille fell into the hands of the besiegers with scarcely any resistance; and fortress after fortress surrendered. Two months sufficed to put the whole province of Flanders in the power of Louis. At the same time Condé, who was governor of Burgundy, received instructions from the king in consequence of which he invaded the Spanish territory of Franche Comté at the end of 1667, besieging Dôle in the middle of winter, contrary to the usual practice of those days, and conquering the whole territory with a rapidity surpassing that of Turenne, and reminding us of the "*Veni, vidi, vici*" of Cæsar. Thus the triumph of the French king seemed complete.

Conquest of Flanders.

But this unprecedented display of armed aggression had excited the grave apprehensions of various European powers, especially of Holland, which, situate on the borders of Louis' dominions, might expect to be the next object of the king's warlike attempts. The English parliament also, made fully aware of the danger impending, began to remonstrate seriously, in which Sweden loudly joined. A coalition against France of the various maritime powers was threatened; and chiefly by the persistency and determination of the Dutch envoy Van Beuring, the treaty of Aix la Chapelle was brought about in 1668, by which Louis reluctantly gave up Franche Comté to the Spanish king, though he retained his ill-gotten booty in the Low Countries, thenceforth known as the province of French Flanders. The cession of those valuable fortresses revealed the weakness of the Spanish monarchy.

Intervention of Holland.

Treaty of Aix la Chapelle, 1668.

Soon afterwards, the triple alliance concluded between England, Holland, and Sweden (alluded to under Charles II.) afforded another safeguard against the ambition of Louis; but both England and Sweden were bribed by the French king to prove false to their engagements, the shameful bargain of the treaty of Dover being concluded with Charles II., by the intervention of the English king's sister, the Duchess of Orleans. Charles II. was gratified with his infamous pension, and Louis was free to execute the vengeance he had sworn against the Dutch republic for thwarting his ambition.

Triple alliance.

We come now to the year 1672, when Louis, accompanied by an army of a hundred thousand men, under the command of both Condé and Turenne, invaded Holland and lit the torch of war that produced a general conflagration in Europe. But of this we shall speak in our next article.

V.

The Immediate Predecessors of Chaucer.

Among the immediate predecessors of Chaucer, the "father of English poetry," stands forth Robert, or as some writers have called him, William Langland, the author of the remarkable allegory, *The Visions of William of Piers, Ploughman.* Langland, of whom we know very little, is described as a secular priest of Shropshire. He was evidently a Wickliffite, and full of zeal against the abuses that had become rampant in the Church. The laziness, luxury and rapacity exhibited in many of the convents by unclerical clerics, had become unbearable; and the foundation of the mendicant orders—the Dominicans, Augustines, Franciscans, and Carmelites, the *poor* orders, who by their preaching and living were to shame the luxury and licentiousness of the times—had not fulfilled its object. These orders were respectively known, from their habits, as the Blackfriars, Whitefriars, and Greyfriars. Langland has aptly been compared to "the voice of one crying in the wilderness." He is the advocate of the people against a corrupt clergy and a rapacious nobility, lifting up his voice boldly for the oppressed, denouncing hypocrisy and wrong, and upholding what is honest and true. Going forth on Malvern Hills, he sits down to rest, and falls asleep; and then he has a wondrous vision which in some of its features seems to anticipate that still more wondrous 'Dream' that came to John Bunyan centuries afterwards. There is a Tower of Truth, with Grace for its portress, a Dungeon of Care, which recalls the cave in which Bunyan's 'Despair' sat brooding; then there are the personifications of Good—Dowell, Dobet (Do better), and Dobest; and as a contrast to these comes Friar Flatterer with Bribery and Avarice. Conscience and Theology are also personified. The author is vehement against the abuses of his time, and his trumpet gives forth no uncertain sound. The language is the plain Saxon of a country dialect, without ornament or decoration of any kind. The writer uses the device of alliteration, making the principal words of each line begin with the same letter; for "Apt alliteration's artful aid," as Pope illustratively describes it, was an old Anglo-Saxon device. The lines in which the author speaks of the future destruction of the monastic houses by the hands of a king were strangely verified in later times. Another work called *Piers Ploughman's Creed*, similar in tone and intention to the *Visions*, is either by Langland himself, or by a close student and imitator of his manner of writing.

Langland, and the Vision of Piers Plowman.

Nature of the allegorical satire.

Remarkable prophecy.

The following lines will give an idea of

Piers Ploughman's Vision. The author is severe upon the pride of the churchman, who expects the servitor to kneel to him:—

"And now is religion a rider, a romer by the streete,
A leader of lovedayes and a loude beggar,
A pricker on a palfrey from maner to maner,
An heape of houndes at his ['heel'] as he a lord were.
And yf but his knave knele, that shall hys cope bryng,
He loured on hym, and asked who taught him curtesye."

The opening lines, which explain the poet's intention, are as follows:—

"In a summer season when soft was the sun
I shoop (wrapped) me with shrouds (clothes) as I a sheepe (shepherd) were;
In habit as a hermit unholy of werkes (a roaming hermit)
Went wide into this world, wonders to hear;
As on a May morwening on Malvern hills me befel a ferly (wonder).
I was weary for-wandered and went me to rest,
Under a brood (broad) bank by a burn's side,
And as I lay and leaned, and looked on the waters,
I slumbered into a sleeping, it swayed so mury (sounded so merry).
Then gan I to meten (meet) a mervelouse sweven (dream),
That I was in wildernes, I wyst never where:
As I beheld into theast (the east), on highe to the sunne
I saw a tower on a loft, rychlych ymaked,
A depe dale beneth, a dungeon therein,
With depe diches and darcke, and dreadfull of syght:
A fayre felde ful of folke found I ther betwene,
Of all maner men, the meane and the riche,
Working and wandring, as the world asketh;
* * * * * * *
Thus robed in russet, I romed aboute
All a somer season, for to seke DOWEL (Do-well),
And freyned (inquired) full oft, of folke that I mette
If any wight wist wher DOWEL was at inne (dwelt),
And what man he might be, of many man I asked.
Was never wight as I went, that me wysh (inform) could
Where this ladde lenged (lived), lesse or more,
Tyll it befell on a Fryday, two fryers I mette
Maisters of the minours, men of greate wytte.
I halsed (saluted) hem hendelye (handily), as I had learned,
And prayed hem for charitie, or they passed furthur,
If they knewe any courte or countrye as they went
Where that DOWELL dwelleth, do me to wytte (know)—
For they be men on this mould, that most wide walke
And knowe contries and courts, and many kinnes (kinds of) places,
Both princes palaces, and pore menes cotes,
And DOWEL and DOEVIL, where they dwell both,
'Amongest us,' quoth the minours, 'that man is dwellinge,'
And ever hath as I hope, and ever shall hereafter.
Contra quod I, as a clarke, and cumsed to disputen,
And sayde hym sothelye (truly) '*Septies in die cadit justus*,
Seven sythes (times), sayeth the boke, synneth the rightfull,
And who so synneth, I say, doth evel, as me thinketh,
And DOWEL and DOEVYL may not dwel togither,
Ergo he is not alway among you fryers,
He is other whyle els where, to wyshen the peeple.'"

Among the authors of that early period, a place of great honour must be assigned to JOHN WICKLIFFE (1324—1384), 'the morning star of the Reformation." At a time when the degeneracy of the priesthood and the lofty pretensions of the papacy were exciting mingled anger and apprehension in England, it was this courageous clergyman, the professor of theology at Balliol College, Oxford, and afterwards vicar of Lutterworth, who stood boldly forward to denounce wrong wherever he found it. Like Langland, he objected to religion's assuming the luxurious or the mendicant form, as "a pricker on a palfrey," or as "a loud beggar." Arraigned by the papal legates on a charge of heresy, at Lambeth Palace, in 1378, his real offence being that he had preached and written against ecclesiastical luxury, vice, and imposture, Wickliffe was summoned to appear before Convocation at St. Paul's—for it was thought necessary to silence the outspoken priest, who in strong though homely phrase declared to the bishops that they were "choked with the tallow of worldly goods." Wickliffe appeared to the summons, but not alone. He was accompanied by no less a personage than the great Duke of Lancaster, John of Gaunt, and by Earl Percy, Marshal of England. Gaunt bade the courageous reformer be seated, declaring "he had need of a soft seat on which to rest during so tedious an attendance." This led to opposition on the part of Courtenay, Bishop of London; and a tumult ensued, in which the Savoy, the palace of John of Gaunt, was sacked by the mob, but for the time the reformer escaped. Subsequently, however, four different bulls were issued in one day against Wickliffe by Gregory XI., and he was cited to appear before a synod of papal legates. The result would most probably have been the trial and death of the heroic clergyman; but again came a powerful interposition in his favour—this time from the citizens of London, who besieged the chapel where the synod was held, and defied the assembled prelates. The queen-mother, too, sent a message prohibiting the conclave from pronouncing sentence on Wickliffe; and thus the great reformer, rescued from imminent peril of a martyr's death, lived to lift up his voice more boldly than before in behalf of justice, morality, and truth. In the doctrines set forth by Wickliffe, and zealously disseminated by his followers, we have the beginning of the great movement that agitated Europe a century and a half later. A writer of our own day has well observed that though a hundred and fifty years separated Wickliffe from the great German reformer, who was more conspicuous in the task of bringing the conflict between unfettered reason and ecclesiastical despotism to a decisive issue, the vicar of Lutterworth must be regarded as the *fons et origo* of the Reformation. He taught that the sovereignty claimed by the pope over secular powers "had never been delegated by God to any man," that the authority of the crown was supreme over all persons and property in England, and that the king was bound to see that temporal goods were not wasted or misapplied by the clergy. He maintained that the ultimate appeal on doctrinal points was not to the court of Rome, but to Scripture.

Wickliffe, the first English reformer.

Influence of Wickliffe's preaching and writings.

The great and undying service that Wickliffe did to his country was by the translation of the Bible from the Latin version into English. The following extract from the sixteenth chapter of St. Luke, giving the parable of the unjust steward, may be taken as a specimen of Wickliffe's style:—

"Forsothe he seide also to his disciples, Ther was sum riche man, that hadde a fermour,

ether a baily; and this was defamyd anentis him. as he had wastid his goodis. And he clepide him, and seide to him, What heere I this thing of thee? yeld resoun of thi ferme, for now thou schalt not mowe hold thi ferme.

Extract from Wickliffe's Testament.

Forsoth the fermour seide with ynne him silf, What schal I do, for my lord taketh away fro me the ferme? I may not delue, I am aschamyd to begge. I woot what I schal do, that whanne I schal be remouyd fro the ferme, thei receyue me in to her housis. And alle the dettours of the lord clepid to gidere, he seide to the firste, Hou moche owist thou to my lord? And he said to him, An hundrid barelis of oyle. And he seide to him, Taak thin obligacioun, and sitte soon, and wryt fifti. Aftirward he seide to another, Sothli hou moche owist thou? Which seide, An hundrid mesuris of whete. And he seide to him, Tak thi lettris, and wryt foure score. And the lord preiside the fermour of wickidnesse, for he hadde don prudently; for the sones of this world ben more prudent in her generacioun than the sones of light. And I seie to you, Make to you frendes of the richesse of wickidnesse, that, whan ye shulen fayle, thei receyue you into everlastyne tabernaclis."

V.

SOUND (*continued*).

WE have yet to learn several very important facts concerning the vibration of strings, and these will be best understood by taking a long and heavy rope, (an india-rubber tube loaded with sand answers best), and fastening it at one end to a hook near the ceiling of a lofty room. If the other end be held in the hand and the rope be slightly stretched, it will be an easy matter to swing the rope to and fro as a whole, as in fig. 17, p. 636, and it will be found that it has a definite period of vibration which depends upon its length, weight, thickness, and tension. If now the vibration of the rope as a whole be stopped, and a sudden jerk be given to it, a wave will run up the rope on one side and back down on the other side as shown in fig. 18, p. 637. It will be found that it takes exactly as long for this wave to pass from the hand to the end of the rope and back, as it did for the rope to make one complete vibration as a whole. If care be taken to give a second jerk to the rope just as the first one is returning from the fixed end, the foremost parts of each wave will meet the middle of the rope at the same moment, one going up, the other going down. Consequently the middle point of the string will be acted upon at the same moment by two precisely equal and opposite forces, the ascending wave tending to pull it to the right, the descending wave tending to pull it to the left; it will therefore go in neither direction, but will remain at rest (fig. 19, p. 637), and the two halves of the string will oscillate separately and independently. In this way two *stationary* waves are produced, A B and B C, fig. 19. To these vibrating parts of the rope, and to the motionless point between them, names are given of which we shall hereafter have to make considerable use: the vibrating parts A B, B C, are termed *ventral segments*, the point of rest between them is termed a *node*.

Wave-like vibration of strings.

We have now seen that a string can be made to vibrate either as a whole, or in two separate parts. In the first case the whole of the string forms a single ventral segment, and the two fixed ends are nodes; in the second case the string is divided at its middle point into two ventral segments, separated by a node. These are, however, by no means the only ways in which a transversely vibrating string may be made to vibrate. It may be made to divide into three ventral segments separated by two nodes, into four ventral segments, separated by three nodes, and, indeed, into an almost infinite number of vibrating parts. We will, however, confine ourselves to a consideration of the first two or three nodes of division of which vibrating strings are capable.

Division of vibrating strings.

If any of our readers should try the experiments with the loaded india-rubber tube or heavy rope mentioned above, and of which they will find a fuller account in Professor Tyndall's excellent work on Sound, they will find that the greater the number of segments into which the rope divides the more rapid will be the rate of its vibration; in fact, as one would be led naturally to suppose, the number of segments and the rate of vibration are precisely proportional to one another. The relation of the number of segments to the note produced can be well illustrated by our monochord.

Relation of rate of vibration to number of segments.

If the fixed string of the monochord be set vibrating as a whole, it will be found that it can be made to vibrate in segments by simply touching a point in it lightly with a feather, the number of segments produced depending upon the point of the string so "damped." If, for instance, when the string is vibrating as a whole the middle point be damped, the string immediately begins to vibrate in two segments, each segment giving out the octave of the fundamental note; if a point one-third of the length of the string from either end be damped, the whole string vibrates in three parts, and the note emitted is the fifth above the octave of the fundamental tone. Finally, if the point damped be one-fourth from either end, the whole string swings in four parts, and gives out a note which musical ears will at once recognise as the double octave of the fundamental; further divisions of the string are possible, but these will suffice for our present purpose. To prove that when the string is damped at one-third or one-fourth

Results of damping strings at different points.

of its length from either end the remaining portion of the string divides into two or three vibrating segments separated by nodes, the following interesting experiment may be performed :—

Take some small slips of paper and fold them in two, and place one exactly where you expect each node to be, and one in the middle of each vibrating segment, as in fig. 20; when, having damped the string you set it in vibration, it will be found that the paper riders set on the middle of the ventral segments will be violently thrown off, while those on the nodes will retain their places. It will be noticed

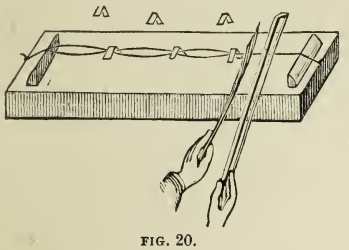


FIG. 20.

that although the pieces of paper placed on the nodes are not thrown off, they vibrate more or less intensely ; the nodes, in fact, are points only of *comparative*, not *absolute* rest. These experiments show conclusively the manner in which transversely vibrating strings may be made to divide themselves, and the various notes emitted show that the number of vibrations is precisely proportional to the number of ventral segments.

Quality of musical sounds.

We may, however, learn much more than this from our monochord, for we may solve what was for a long time the mystery of the differences in the quality or *timbre* of the same notes emitted by different instruments or voices. Every one is familiar with the fact that although twenty different persons may sing, or twenty different instruments sound, precisely the same note, yet the note given by each instrument or each person has a peculiar something in it which enables us to distinguish it from all the rest ; any one, for instance, can distinguish between the middle C of the piano and the same note of the violin, harp, key-bugle, or flute. To this difference in the same note when emitted by different instruments, or sung by different persons, we in England usually give the term *quality*, the French call it *timbre*, the Germans *klangfarbe* or *clang-tint*.

Overtones, or harmonics.

For a long time the exact cause of this difference was a mystery ; no difference whatever could be detected in the number of vibrations, and it was perfectly certain that difference in amplitude could have nothing to do with the difference in quality. At last the matter was set at rest by the celebrated German physicist Helmholtz. He conclusively showed that when any given note is sounded that note is by no means a perfectly pure note, but is mingled with a number of other notes higher than itself, which he terms *overtones*, and which by others are less happily termed "*harmonics*" ; the fundamental tone is, of course, predominant, but it is very considerably modified by the particular overtones which mingle with it. In different instruments and voices different overtones mingle with the fundamental, and so modify as to give it in each instance a definite quality. Helmholtz has also experimentally proved that if you strip the notes of different instruments of their respective overtones the sounds they emit will be identical and indistinguishable ; moreover they will be extremely flat and monotonous, so that we owe the beauty of our music almost entirely to overtones.

If the string of the monochord be plucked at different intervals along its length, it will in all cases, of course, give out its fundamental tone, but it will be found that the character or quality of that tone perceptibly alters in each instance. This arises from the fact that when you pluck a particular point of the string you must necessarily banish from the string those overtones which require that point for a node, because by virtue of your plucking it you make it the centre of a ventral segment ; if the banished overtones were discordant with the fundamental, the latter will have its quality improved ; if the overtones were accordant, the quality of the fundamental will by their absence be deteriorated.

Confirmatory experiments.

That the absence of certain overtones from a vibrating string when the point plucked is one which those overtones require for a node, may be demonstrated with the monochord. The first overtone is, of course, the octave of the fundamental, which requires the middle point of the string for a node. Pluck the middle point, and, while the string is vibrating, gently damp the middle point ; the fundamental is, of course, quenched, but no first overtone will be heard. If, on the other hand, some other point of the string be plucked, and the middle point be subsequently damped, the first overtone will be distinctly heard. In the same manner various other points of the string may be damped and the corresponding overtones destroyed. Helmholtz has shown that the sixth and eighth overtones of a string are discordant with the fundamental, and this explains why it is that pianoforte makers find it best to make the hammers of a piano hit the strings at about $\frac{1}{7}$th to $\frac{1}{9}$th of the length of the string from its upper extremity ; if the hammer strikes this portion of a string it makes ventral segments of those points which the sixth and eighth overtones require for nodes. The success with which discordant overtones are banished from a string has much to do with the brilliancy of the note produced. The overtones suppressed or exalted also depend upon the weight of the hammer and the degree of the promptness of its action.

Transverse vibrations of rods.

Turning from the consideration of the transverse vibrations of strings fixed at both ends to those of rods similarly stretched, we find that while the divisions of rods fixed at both ends cor-

respond precisely with those of a stretched string, the overtones differ in their relation to each other and to the fundamental note. As will be remembered, the succession of notes produced by the transverse vibrations of a stretched string is in the natural order of the numbers, 1, 2, 3, 4, 5, 6, etc.; but in a rod fixed at both ends and vibrating transversely, the overtones are to each other as the squares of the odd numbers 3, 5, 7, 9, etc. The relation of the number of nodes to the number of vibrations may, therefore, be represented as follows:—

Number of nodes . .	0	1	2	3	5
Number of vibrations.	9	25	49	81	121

The reason of this difference between the ratio of the notes of a string and those of a rod is that in the string the vibrations are maintained by an external force applied to the string, while in a rod they are maintained by the elasticity of the material of the rod itself.

Rods fixed at one end can also be made to vibrate as a whole or in segments. The rate of vibration of the fundamental tone is to that of the first overtone as the square of 2 to the square of 5; after this the relation between the successive overtones is as the squares of the odd numbers 3, 5, 7, 9, etc. With rods of different lengths it is found that the rate of vibration is inversely proportional to the square of the length of the rod.

Vibrations of a rod fixed at one end.

Rods may also be so arranged as to be free at both ends, as is the case in the glass harmonicon. When so fixed, the simplest mode of division is into three parts by two nodes, each of which is about one-fourth of the length of the rod from the nearest extremity. The next division is into four vibrating parts, separated by three nodes. The relation between the nodes and the number of vibrations of a rod free at both ends may be represented as follows:—

Rods free at both ends.

Number of nodes. .	2	3	4	5	6	7
Number of vibrations.	9	25	49	81	121	169

The lower figures, it will be seen, are the squares of the odd numbers 3, 5, 7, 9, 11, 13.

In music advantage is taken only of the fundamental tones of rods free at both ends; and this is well seen in the glass harmonicon, where the separate plates are suspended through the nodes. A

The claque-bois.

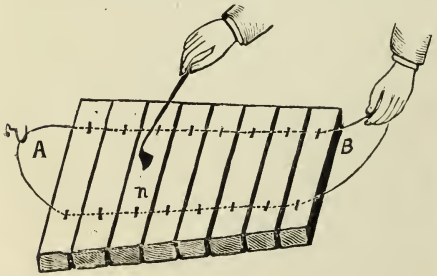


FIG. 21.

similar arrangement obtains in the French *claque-bois*, a representation of which is given in fig. 21. This instrument consists of a number of pieces of wood of different lengths, widths, and depths, strung together through the nodes. One end of the string is placed upon a hook, *k*, while the other end is held in the hand, the various notes being struck by the hammer, *h*.

From what has been said about the vibrations of a rod free at both ends, it is easy to pass to a consideration of the vibrations of a tuning-fork. In fig. 22, let *a a* be a rod of steel free at both ends; when sounding its fundamental note the nodes will be found at the points indicated by the dotted lines. It is found, however, that if the bar be gradually bent upwards, these nodes as gradually approach each other, as shown in *bb*, *cc*, *dd*, and *ee*, so that when the bar is bent into the shape of a tuning-fork, the nodes, when

Vibrations of a tuning-fork.

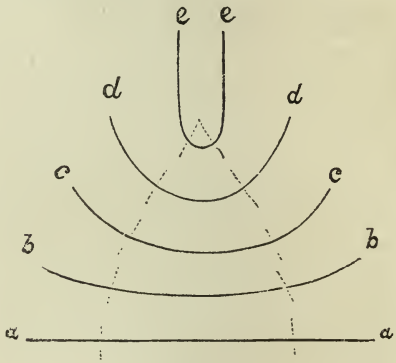


FIG. 22.

the fundamental note is sounded, are at the bottom of each prong. In the second mode of division of a tuning-fork there are still two nodes at the bottom, and also one on each prong. In the third mode of division of the fork, two nodes appear on each prong, but only one at the bottom. Chladni determined the rate of vibration of the first overtone to be six and a quarter times that of the fundamental; but this is by no means always the case, as tuning-forks are frequently found to have their overtones discordant while their fundamental tones are the same. After the first overtone the sequence of the notes is as the squares of the numbers 3, 5, 7, 9, etc.

ZOOLOGY.

XXI.

THE AQUATIC CARNIVORA.

MANY things in structure must necessarily be different in animals habitually dwelling in the sea or gaining their food in the ocean. If rapid swimming is for the creature a means of

safety or success in life, a very rounded form of the central parts is met with, the limbs are shorter, and the digits are encased in thick and strong tissues, becoming by this simple method converted into fins. In those now under consideration, the short tail and the hind-limbs, extended backward parallel with it and connected by a strong fold of skin, become almost identified, and thus constitute a powerful swimming member; while the fore-limbs are very capable aids in swimming and steering the creature by varying the direction of stroke. Fatty tissue under the skin to a considerable depth, and thick hair and fur as an outside covering, prevent that loss of heat which in mammals would reduce the bodily temperature too far when in the sea. The heart is powerful, and the capacity both of blood vessels and lungs is great. Thus the seals can keep under water without breathing for half an hour, when they have taken in a good supply,—a most useful provision for deep-sea fishing excursions, or for aiding escape from enemies. The brain is more complex in its foldings in these marine creatures than in their most cunning fellows on land. The brain proper almost covers the cerebellum or hind-brain. We are necessarily ignorant of many points about their natural habits, although some exhibit great docility and teachableness in captivity. Yet, if high capacity of memory or acquirement were taken to indicate great amount of brain-folding, we should look to the dog for this pre-eminently; but it is by no means found that the dog is comparable to the seals or the dolphins in complexity of brain structure. The seals are particularly acute in hearing; and since both water and ice conduct sounds excellently, their natural residence accords well with this faculty. So perfected is the internal organ of hearing that the external ear-lobe is either absent or very small in comparison with that of land-animals.

Adaptations for aquatic life.

Provision for warmth and breathing.

Brain and senses.

The Walrus, inhabiting the seas of the Arctic circle and the coast ice of Greenland and Labrador, to Behring's Straits, is celebrated for its enormous size and for its great tusks, which are really large canine teeth, protruding downwards and curving slightly backwards. The lips and cheeks are beset by long and strong bristly hairs; and these, with a blunt nose, small eyes, and nothing but an opening to indicate the ear, give the walrus its strangeness of countenance. The back is extremely broad, and the ribs large and widely extended outwards. The fore-limbs are comparatively short, and the hind-limbs naturally stretch backwards, having folds of skin connecting them with the tail, which is of moderate length. Here the special characters of the carnivora as to grinding teeth and claws disappear. The nails are but slight things upon the surface of the flipper, while the grinders are simple and similar to one another, and have been compared to pegs. The big tusks are not only useful in enabling the animal to clamber in its scrambling fashion upon the ice, but also to dig into the sand or shingle and drag up shell-fish of various kinds, which the creature feeds upon. Whale-flesh is not disdained, but we have no information to indicate that the walrus has a disposition inclining it to kill whales or dolphins. The polar bear is a noteworthy enemy, though not so dangerous or destructive but that the numbers of walruses were still great before man's predaccous spirit became excited against these fine creatures. Herds of a thousand are not now to be seen so commonly as they once were; and the day will doubtless come when walrus tusks of two feet long, and carcases weighing a ton, will be merely antiquarian reminiscences. Two things are notable among the habits of these creatures: their power of long fasting, not especially in winter, but in the warm weather of autumn, and on land; and their sleeping in the water seated, if we may so call it, in an upright position.

The walrus.

Teeth and tusks.

Decrease in numbers.

Walruses appear, as a rule, to have but one young one at a birth, and the mothers suckle them assiduously for a long period. The canines are not of a useful size till about two years after birth. In protecting her big baby from danger the walrus is capable of becoming truly savage, and makes remarkable efforts rather than desert her young.

The young walrus.

Naturalists are able clearly to distinguish two great groups among the seals, in the first place by the presence or absence of external ear-lobes. It is found, however, that this distinction is accompanied by others which are of still more apparent importance; for the eared seals can walk on land more actively than the walrus; but the earless seals have shorter fore-limbs, with the fore-paw free for walking and the hind-limbs closely fastened to the tail by skin folds, leaving the feet free only for motion in the water and not on the land.

Eared and earless seals.

Just as the term "sea-horse" has been given to the walrus, showing a not very correct appreciation by mariners of resemblances among animals; so the eared seals have received the denomination of sea-lions, wolves, dogs, bears, leopards. Two groups are commonly known among eared forms,—namely, Fur Seals and Hair Seals; but these fur seals are not the only ones which yield marketable fur, and the fur is just as deserving of the name of hair as the covering of the hair seals. Fur, especially seal fur, is composed of fine soft hairs very closely set and fixed in the original skin, which has undergone a variety of processes. This coating of hairs, however, is not that which is most evident at first; just as the "down" of most birds is not that part of the feathery coat which constitutes the prominent feathers. The hair seals have the longer, stouter, and coarser hairs relatively more abundant than the fine under-hairs, while the fur seals have the under coating of soft hair very thick, and constituting much the greatest portion of the hair. In order to prepare the warm sealskin clothing so much valued

Fur and hair seals.

Nature and preparation of fur.

at the present time, the long hairs have to be got rid of. This is done, not by cutting them short so as to be uniform with the rest, but by shaving away the underside of the skin, in which the longer hairs are seated. When this has been accomplished the roots of the long hairs are cut off, and they can be combed out of the fur. This is, however, not the only process needed in the manufacture of the valued fur as an article of commerce; dyeing and various operations of softening and preservation are required before the gloss and flexibility of the admired sealskin garment are obtained.

The coldest climes and waters, with the icy expanses of the Arctic and Antarctic Circles, are the localities favoured by the seals; some among them come to our own islands, and are comparatively abundant in similar latitudes. Briefly to mention even the names, haunts, and habits of all the kinds of seals that can be accurately distinguished would occupy too much space. The great northern Fur Seal (eared) dwells in localities around Behring's Straits, and breeds on the Pribyloff Islands, which, belonging formerly to Russia, are now the property of the United States. In the summer they resort to the shore, and the males, who are at least four times the size of the females, are the first to land, each gaining and keeping, if possible, a particular spot of ground, from which later comers often try to expel them. The positions near the shore are much in favour, for they give to the more powerful males who gain them a better chance of securing the dozen or more wives that they desire for their harem. But, as it would be only natural to expect, many a fight for place and power occurs between the males, and in the midst of these combats the females suffer greatly.

Haunts and habits of seals.

During these months the seals hold their position only by constant watchfulness; and it appears to be authentically recorded that this period is one continual fast and sleepless vigil, during which the fat which the animal at first possessed is being wasted.

Sleeplessness and fasting.

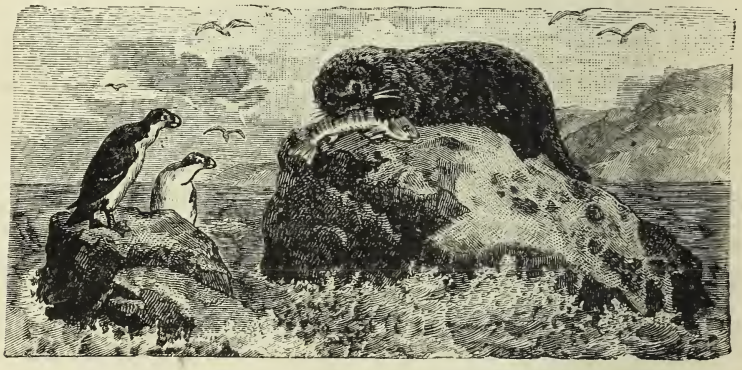
The adult females during this time bring forth one young one each, but they do not show any intense parental affection. The young animals that are not among the conquerors or conquered take special quarters among the vast seal groups, and gambol in a most lively manner during the summer both on sea and land. The seals exist in vast numbers, and previous to the Americans gaining control of these coasts, were killed in most indiscriminate fashion. Now, however, only young males are killed, in numbers such as will certainly not exterminate the species. They are mostly killed on land, the hunter driving forty or fifty males into a group in foggy weather, when they cannot do much to escape or defend themselves, and they are soon knocked on the head with clubs.

Seal destruction.

There is also a much larger eared seal visiting the Pribyloff Islands, called a Sea Lion. Here again the male is much the larger, reaching nearly half a ton in weight. It is a hair seal also, losing almost all its under-fur when mature; but its value is great to the islanders, to whom the hide and the blubber, the flesh and the sinews, are equally of use. Its numbers are not so great, and they have no such complete arrangement of households as the fur seals just mentioned. They are known, however, in a wide range of coast, from Kamstchatka and the north-eastern coast of Asia, even as far on the American coast as San Francisco. The skin is considerably variegated in colour, and really in its look is somewhat like the lion's, notwithstanding some brown and black portions of the body.

Northern sea lion.

Among distinct and noteworthy forms of eared seals that produce furs valued in commerce, we must mention the large Falkland Islands fur seal, which resembles in many particulars the northern fur seal. This seal has learnt to avoid mankind of late years, and to place itself in comparative security on rocks almost always cut off from approach by heavy surf. Yet, like many other seals, it is gradually being exterminated. There are sea lions about the Cape of Good Hope, as well as about New Zealand and various southern islands; but that which has excited most interest in England is



RAZOR-BILL. SEA-OTTER.

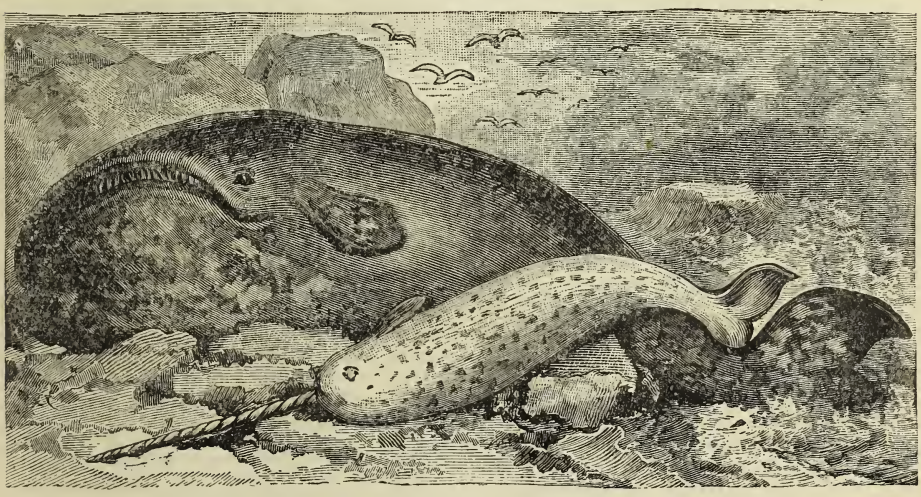
the Patagonian form first mentioned by Magellan (1579), and afterwards described by Captain Cook, hence often known as Cook's Otary. Lecomte, a French sailor, brought the first to England, and acted as its keeper at the London Zoological Gardens, where its obedience and intelligence were remarkably displayed. These sea lions again are polygamous, like the northern forms, and live, when on shore, in organised families and in associated groups, appointing guards, etc. Fish is their diet, varied with shell-fish and crustaceans. This is not one of the fur seals, but a hair seal.

Cook's Otary.

The longest known of the seals is that which frequents the European shores. It is one of the seals without external ear-lobes. This creature can only jerk itself forward in a very unhandy fashion on the ground, where it lies on its belly. Its fore-paws are not much used on land, the bones of the fore-arm and arm being scarcely free to move, and shorter than in larger numbers; but although the skin and body have a very disagreeable odour, yet among the Esquimaux this does not prevent their being hunted with much skill and perseverance, both for the skin and the flesh. They are taken in considerable numbers, either by double sets of large-meshed nets in the water where they are known to pass, or by stealthy waiting with gun or harpoon. The hunter awaits his prey at the mouth of the "atluk," or opening of the oblique channel which the seal has made through the ice to enable him to come to the surface and breathe, or enjoy the sun when it comes out. Lake Ladoga in Russia, Lake Baikal in Central Asia, and the Caspian Sea, have seals inhabiting them which are very closely allied to the ringed seal; and the reason for this close resemblance appears to be in the former connection of all these seas with the ocean in past geological times. In these smaller areas seals were left which have not become modified into distinct species as time has elapsed, but are still recognized by most naturalists as varieties.

Ringed seal.

Seals of inland lakes.



GREENLAND WHALE. NARWHAL.

in the eared seals. The hind limbs are so far carried back and so arranged in combination with the short tail, as to form a broad pair of oars when horizontally set, the great toe then being outwards; but when they are placed together, sole to sole, the two can be worked from side to side, as a scull. Thus their movements are quite graceful in the water; and before they were terrified by human or inhuman treatment, they were often to be seen on our coasts, or at river mouths. But their range truly extends over almost the whole of the European coasts, including the Black Sea. They are also found on the eastern American coasts from Greenland downwards, being met with as far southward as Florida. They are by no means so numerous as some larger forms of seals whose furs are valued, yet the quality is good. They are from three to six feet long, and yellowish-grey in colour, with some spots of a darker hue but lighter below. The Ringed Seal is found

European seals.

The Saddle-back Seal is that which is most hunted by the Dundee and northern sealers, although it is not a fur seal; but the blubber is considerable in proportion to the size of the animal, and the hide is converted into leather. Vast numbers are slaughtered in sealing expeditions to Spitzbergen and Newfoundland. The details of these voyages include sickening accounts of butchery and almost indiscriminate slaughter of young and old, on the ice floes, whither these seals resort to breed.

Saddle-back seal.

The Monk Seal is an interesting seal from the Mediterranean and Black Seas, noted for its docility, and for making sounds which are interpreted as language; hence it is often called a "talking fish," and exhibited as a marvel of nature.

Monk seal.

The Crested Seal is the last seal from the

north that we shall mention, though it is far from exhausting the list. It

Crested seal.

has a peculiar dilatation of the cartilages and skin of the nose, with an enlargement of the bony parts, which renders the creature more difficult to kill by a blow. While any of these parts remain flexible, the animal inflates them strongly when attacked or excited, and it is capable of fighting more ferociously than the majority of seals, at the same time making loud-resounding roars, heard for miles.

The Elephant Seal is truly notable for the size it attains, although its name is derived from the prominence of its nasal

Elephant and leopard seals.

organ, which in old males protrudes a foot beyond the tooth-bearing palate. The males have been known to reach twenty feet in length, while the females are not half as long. They are found in considerable numbers on various groups of islands and territories in the Southern Antarctic Circle. The skin, though not valuable for its fur, is extensively used for carriage and horse harness on account of its great strength; but its oil is the chief object for which the animal is hunted. The tongues, when salted, are considered savoury and wholesome. The Sea Leopard is a smaller form, spotted with dark patches on lighter ground, known on Australian and New Zealand coasts as well as in Antarctic localities. The teeth are notable as including grinders or "molars," which are serrated, having three prominent sharp elevations, reminding one of the teeth of some of the land carnivora.

Thus we have briefly treated some of the more notable aquatic animals allied to the lions, tigers, and bears. Their interest for us is great; but naturalists, and, indeed, the humane generally, would have far more pleasure in studying their habits and structure did they not feel that the seals, as much as any group of animals, have been made victims of man's greed for gain and taste for wanton slaughter. When helpless mothers and young are carelessly destroyed because they are easiest killed, it is grievous to think that in future times those who have not committed the cruelties which have cut off these fine animals will be the losers by their extirpation.

The British government might do much to preserve the various species of seals if it would enforce regulations limiting the number killed each year in seas and on islands under its control, in the same way that the Congress of the United States has limited the number to be taken annually by the Alaskan Commercial Company. Organization will secure much better results at a less cost than isolated and uncontrolled proceedings. In former times in Alaska three-fourths of the skins taken were rejected as valueless commercially. All these animals' lives might have been spared.

It is thus that greed defeats its own ends; and just as in the old story the goose was killed that laid the golden eggs, so we have seals slaughtered and a capital squandered that might have been drawn upon for ages.

XLVIII.

SYNTAX OF THE VERB.

Direct and Indirect Questions, and the Subjunctive with the Relative.

THE direct question is expressed in Latin generally by the help of interrogative particles such as *quid*, why, which always goes before the word—as *Quid rides?* why do you smile? or such as *ne*, subjoined to the first word—as *Putasne me stultum?* do you think me a fool? The other interrogative particles used are these:—

1. *Num*, which expects the answer *no*, as *Num ridet?* he does not smile, does he?

2. *Nonne*, which expects the answer *yes*—as *Nonne ridet?* He does smile, does he not?

3. *Utrum . . . an*, whether, used only when two alternatives are spoken of—as *Utrum nobilis an ignobilis est*, whether is he noble or ignoble?

Indirect questions are those which are quoted as having been asked, or are made dependent upon some word expressing *doubt*, *uncertainty*, *wonder*, or *apprehension* in the former portion of the sentence—as *Rogabo quid factum sit*, I will ask what has been done. Observe that in the indirect question not only is the dependent verb placed in the infinitive mood, but the laws of sequence of tense already given are to be strictly observed. Notice, too, the following subjunctive uses of the relative *qui*:—

1. *Hypothetical.*—Here *qui* = suppose one who—as in *Quæ qui videat*, suppose one who should see what things.

2. *Causal.*—Here *qui* = *quippe qui*, inasmuch as, since he is one who—as in *O fortunate pater, qui talem natum habeas*, O fortunate father, because thou hast such a son!

3. To express a *purpose*—as *Cæsar mittit eum, qui clamet*, Cæsar sends him for the purpose of crying out.

4. To express a *result*—as *In pellendis civibus, quod vitandum sit, erat nimium sævitiæ*, in the expulsion of the citizens, a result to be avoided, there was too much severity.

Observe also that *qui* is used with the subjunctive mood after such adjectives as *dignus*, worthy, *indignus*, unworthy, *idoneus*, suitable, and such qualitative and quantitative adjectives as *is, talis, quantus*, as well as such phrases as *sunt qui, non desunt qui reperiuntur qui; inventi sunt qui*, there are some who; there are not wanting men who; men are found who; men are discovered who. As for example in—

1. *Ille dignus est, qui summos honores capiat*, he is worthy to receive the highest honours. Here really *qui* marks *a purpose*.

2. *Ego talis sum, qui nihil timeam*, I am such a one as to fear nothing. Here *qui* seems to mark the *result*.

3. *Fuere qui me innocentem esse crederent*, there were some to believe me innocent. Here we have really the subjunctive after the principal verb *fuere*.

The use of the Subjunctive Mood, *standing by itself*, may be classified as *Potential*, to mark ability; *Conditional*, to mark condition pure and simple; *Concessive*, to mark permission; *Optative*, to mark desire; *Dubitative*, to mark doubt; *Hortative*, to mark exhortation. Now, you must observe that in each of these cases the subjunctive mood is not strictly speaking a subjunctive or subjoined mood *at all*, as it has no other clause and no other verb in connection with it. It stands absolutely alone, with its own distinct force, whether concessive, dubitative, etc. For example, if I say, *Dic mihi, quo me vertam*, tell me, whither I am to turn myself, then we have *vertam* in a subjunctive mood, as it is evidently a subjoined verb, depending on the principal verb *dic*. But if I say, *Quo me vertam?* whither should I turn? the verb has a *dubitative interrogative sense*, and is not strictly speaking in the subjunctive mood at all, as it is not subjoined to any verb.

The following examples will illustrate the different senses of the Subjunctive Absolute verb.

A. POTENTIAL SENSE.

Dicat quispiam, some one may say.
Ita amicos pares, thus you may get friends.
Hoc nullus dubitaverim, this I can in no wise doubt.
Hoc pro comperto affirmaverim, this I can aver as a certainty.

B. CONDITIONAL SENSE.

Velim tecum esse, I could wish to be with you.
Mallem aliter rem cessisse, I would rather the affair had turned out differently.

C. CONCESSIVE SENSE.

Hæc sint falsa, granting that this is false.
Fuerit Carbo seditiosus civis, suppose Carbo was a seditious citizen.
Ne sit summum malum dolor, malum certe est, allowing that pain is not the greatest evil, an evil it surely is.
Fueris dignior quam Plancius, very likely you were worthier than Plancius.

D. OPTATIVE SENSE.

Vincat utilitas reipublicæ! may the interests of the country prevail!
Serus in cœlum redeas! may it be long before you return to heaven!
Stet fortuna domus, may the prosperity of the house endure!
Ita vivam, ut te amo, so may I live, as I love you.

E. DUBITATIVE SENSE.

Quò me vertam? whither should I turn?
Quid hoc homine faciatis? what could you do with such a man as this?

F. HORTATIVE SENSE.

Nos imitemur Demosthenem, let us imitate Demosthenes.
Rerum tuarum tu satageres, you should have found enough to do with your own affairs.

In all cases where the subjunctive is found as in the examples given above, in propositions which to all appearance are absolutely independent, the subjunctive is really dependent on some *condition, thought, feeling*, or *limitation* present in the mind of the speaker or writer, though not expressed. For example, when we say in Latin *Quod hoc homine vos faciatis?* what are ye to do with that man? we can fancy either *quæro*, understood, I inquire what, or *miror*, I wonder what; then *thought* and *feeling*, though not expressed, are in the mind of the speaker or writer, and really govern the verb in the subjunctive mood.

In the following and other vocabularies for the future, I shall give you, not as hitherto the mere meanings of certain words, but words with their exact distinctive meanings, as compared, or rather contrasted, with other words of a like or unlike kind, but of similar meaning. This will enable you to do two things well: first, to understand more clearly the meaning of your Latin authors; and next to write the Latin language with perfect accuracy, which you must do with a knowledge of the precise significance of single words and the power of discriminating their nicest and closest shades of meaning. Let me explain this to you by examples. Latin, for instance, has very often two distinct words to express the same thing, but with a difference of sense: as, for example, we have two words to express "black"—*ater, relatively* black or *dark* and *dismal;* and *niger, absolutely* and naturally *black*. So we have *balneæ* for a *public bath*, and *balneum* for a *private bath; epulæ* for a *private feast*, and *epulum* for a *public feast;* so *quies* is simply *rest* from toil, but *requies* is *repose*, sweet and pleasant rest; *semper* is *for ever*, but *unquam, at any time*, or "*if ever at all.*"

Vocabulary of Synonymous Adverbs and Conjunctions.

non is *not* generally; haud = *certainly not*, quite *the reverse*
non dum is *not yet;* in Greek οὔπω
non jam is *no longer;* in Greek οὐκέτι
tunc demum is *not until then*
tunc denique is *then at last*
rursus (for re versus), *again—i.e.* returning (the same line—reversing the process)
iterum, *again*, is going over the same line in the same direction for a second time
denuo (for de novo, a new), *anew*, as if the first effort not successful
de integro = *all afresh*
certe = *at any rate;* certo = *certainly*
verè, *truly;* verò, *but indeed*
sed, *but;* at, *but on the other hand*, always marking a contrast to what goes before. *At* sometimes becomes *ast* before a vowel in poetry. Autem, *but*, always directly after another word.
vel, *or*, of things most like, but aut, *or*, of things very unlike. We can say, *Hic homo vel ille homo*, but not *Hic mons vel hæc vallis.*
plane = quite
omnino = altogether
prorsus = all through (from pro versus)

utique = in any case
penitus = to the very bottom, thoroughly
valdè = very much, strongly (generally used with adjectives)
perquam = in an extraordinary degree
admodum = up to a considerable degree
magnopere = greatly (chiefly used with verbs)
fortuito = without cause
fortè = by chance
fortè fortuna = by good luck, or art
temere = at random
fortasse and forsitan = perhaps, by chance

Observe 1. fortasse verum est = perhaps it is true; it is *probably* true
2. forsitan verum sit = it may be true perhaps; it is *possibly* true; or
3. haud sciam an verum sit = I think it is true, though I will not positively assert it.

Translate into English :—

Estne voluptas plane summum bonum? Nonne fuit Socrates prorsùs antiquorum philosophorum sapientissimus? Nonne sol perquàm major est quàm hæc terra aut luna? Num ita timere audes mihi dicere? Tunc denique fiet, ut mea omnia meum portem? De antiquo libri scriptum est, quominus omnibus mendis careat. Id vero faciam, ut scripta mea tibi omnium placeant. Utrum est aurum gravius an argentum? Haud scio an hoc verum sit, at admodum dubito. Dic mihi, utrum hæc forsitan vera sint. Magnopere molitur ut mihi utique succurrat. Nonne urbs Roma a Gallis capta et directa est? Nonne omnes consentiunt Scipionem primarium fuisse virum? Num tu ipse audes dicere hæc benevolo animo facta esse? Utrum Romæ an ruri hibernis mensibus manere mavis? Utrum est turpitudo omnium malorum maximum an non? Utrum hæc benevolo an malevolo animo fecisti? Utrum Cato an Cæsar tibi præstantior et clarior vir esse videtur? Utrum esse an videri bonus mavis? Quæritur utrum hæc vera dicta sunt an non. Non tu denique balneum petes hodie? Quid me rogas, quare epulas hodie forsitan petam. Nonne omnes oportet prorsus vitam tranquillo animo relinquere.

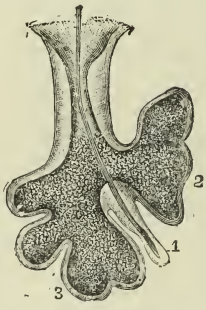


FIG. 13.—SEBACEOUS GLAND, DISTENDED WITH SECRETION.
(*Greatly magnified.*)
1. Minute hair in its follicle. 2, 3. Lobes of the gland distended.

Translate into Latin :—

Are these things so, or do they only seem so to you? I am doubtful whether pain is altogether the great evil it appears to some men. These places are either mountains or valleys : tell me whether I am right in saying this. Was not Pythagoras very worthy to be praised by all good men? It happened by chance that some were found to question the king about all these matters You don't think that I have any doubt, do you, about these matters? I have written the discourse (*sermo*) again, that it might be more correct. Whether is iron or gold most useful to mankind? Whether do you prefer this or that? It cannot, can it be, now a question with any philosopher of learning whether the world is governed or not by a God, wise and benevolent?

Self-Examination Questions.

Distinguish between questions direct and indirect, with an example of each. Give the exact force of *non* and *nonne* and *utrum*, with examples. Give the various forces of subjunctive with a relative *qui*, and also the various senses in which the subjunctive absolute is used. What do you mean by synonymous words? What is their advantage?

HUMAN ANATOMY.

VI.

THE HEAD.

The Face.

WE must now define the parts of the head a little more closely, taking notice of the chief external prominences and openings. The head has two most noticeable divisions, — the more rounded upper and back part, the *brain-case*, and the front and lower portion, the *face*. The brain-case is covered with hair, springing from a movable skin, the *scalp*. The front of the scalp is the *crown* of the head, or *vertex*. The hinder prominent part is the *occiput** and forms the *occipital* region.

Parts of head.

Brain case.

In the *face* we will consider part of the side of the head, so as to include the flaps of tissue forming the ear-lobes and surrounding the external opening of the organ of hearing. The face is somewhat prominent in the middle line, and slopes away to the sides, with a rather sharp edge below, and a greater slope after that, leading to the neck.

Face.

Adjacent to the scalp above, there is a very important and characteristic region, *the forehead*, usually convex from side to side and from above downwards. At either side there is a somewhat greater elevation, (the *temples*,) from which the surface of the head recedes almost at a right angle. Below the upper convexity of the forehead we come down to the less prominent *brow*, overhanging the eyes and nose. The portions immediately above the eyes form the *eyebrows*, often very prominent; while between the eyebrows there is a slope down to the *bridge of the nose*, which rises between the inner angles of the eyes. The eyebrows are clothed with hair.

Brow and forehead.

Eyebrows.

We now descend to the most hollow and concave parts of the face, on either side of that most distinctive feature, the nose. The

* Lat. *caput*, the head.

eyeballs are set in deep pits, defended by the eyebrows and by the promontory of the cheek-bone. The eyeball is covered by two lids, opening horizontally. Both eye-lids are movable, the upper much more than the lower. The upper eyelid is usually seen like a distinct segment of a ring beneath the eyebrow, but this becomes much less prominent when the lid is closed. It may also be noticed that in closing the eyes the lower eyelid is drawn inwards as well as upwards, towards the bridge of the nose.

Eyelids.

The eyelids serve as a further means of protection for the tender organs within, being clothed along their edges with rows of hairs, which, although curved, have a general direction downwards and forwards. These are the *eyelashes*. Those growing on the upper lid are much more numerous, and usually longer, and may catch small particles falling from above. This is their most necessary function, because most of the minute particles in air tend to fall to the ground vertically. When the eye is closed, the two sets of eyelashes come into close contact, the upper resting on the lower.

Eyelashes.

Just at the inner angle of the eye is to be seen a reddish, soft patch, which in some persons becomes large and very red. It marks the situation of the opening of a small canal, which carries off the superfluous moisture of the eyeball, when it does not amount to so much as to overflow and constitute tears. This is the tear-duct or *lachrymal* * *canal*.

Tear duct.

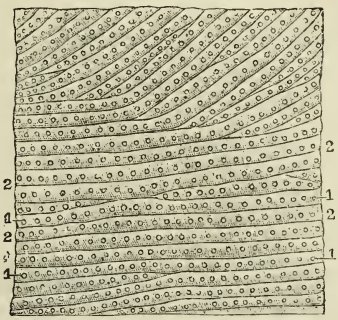


FIG. 14.—OPENINGS OF THE SWEAT GLANDS ON THE PALM OF THE HAND. (*Magnified four times.*)

1. Openings of glands. 2. Furrows between the lines of openings.

Coming now to the eyeball, we find it movable in any direction to a certain limited extent. As far as we can move it we see it to be contained in a white bag, which is composed of tough membrane; this is the *sclerotic* † coat of the eye.

Sclerotic.

Within this, in front, is a sharply-defined circle, enclosing a light or dark-coloured convex surface, the *iris*; ‡ within this again is the small eye-circle which has greatest interest, the *pupil* or "apple" of the eye.

Iris.

Pupil.

Descending on each side and below we have the *cheek*, most prominent over the cheek-bone, and again above the mouth and at its side. The greater part of the cheek covers the firm mass of the upper jaw, while below and outside this it covers the lower jaw, which forms a prominent sharp edge, giving the characteristic outline to the face.

Cheek.

The *nose* is a sort of three-sided pyramid, with its base downwards and one side hidden and fixed to the internal parts. The base is more or less horizontal, and contains two somewhat oval apertures, the *nostrils*, the length of the oval being directed from near the anterior part or tip of the nose backwards and outwards. The outer edge of the nostrils is the thinner and less firm and hard, while the inner edge is bounded by the thick and strong *septum** or partition which descends as a triangle upon the upper lip. Either side of the nose is in general a nearly flat surface, but below the inner angle of the eye there is an elevation corresponding to the end of the nasal bone beneath, and marking the position of some muscles; and below this again is a depression, above the convex lower region around the nostril, which can be distinctly inflated by many people.

Nostrils.

Nasal septum.

With the eyes and nose the *lips* are associated as the most important elements in expression. They are the boundaries of the mouth-opening, but they are among the most mobile of the bodily structures, and consequently can assume almost any imaginable shape. The upper lip is the more convex and arched, being most prominent and thick about the middle, and becoming thinner and more depressed on either side. The lower lip has a general resemblance to the other, but is more horizontally placed. The surface of the lips as seen on the outside is unlike that of any other part of the face in appearance. There are two well-marked regions in each: that which is perfectly similar to the rest of the skin; and that which is red and delicate. There is no precise boundary between these surfaces; they shade imperceptibly into one another, and pass gradually into the lining or mucous membrane of the mouth; the latter however, is always moist, while the external red part of the lips is usually not so.

Lips: mouth-boundaries.

Worthy of notice is the vertical pit in the the upper lip beneath the septum of the nose, as well as the depression below the middle of the lower lip, from which an abundant growth of hair takes place in men. We may also mention the numerous small grooves to be seen on the red portions of the lips when relaxed; these are merely wrinkles, due to the fact that the lips are capable of being stretched much beyond their normal size, when these markings disappear and the surface becomes glistening and smooth.

The chin is the remaining prominent feature, forming a projection where the side-lines of the lower jaw meet in front, and presenting a blunt elevation overhanging what is sometimes the most concave part of the neck, but sometimes, by growth of fat, is very convex and tense, forming a dewlap.

Chin.

Double chin or dewlap.

* Greek *lachryma*, a tear.
† Greek *scleros*, hard, tough.
‡ Greek *iris*, the rainbow (there may be a reference to the varied hues of this part of our structure).

* Latin *septum*, a partition.

With the exception of a part of the forehead, the nose, and a small region beneath each eyeball, the face is in some men found entirely covered with long hairs known as whiskers. Usually, however, a considerable portion of the check, and also a region below the lower lip on the right and left of the middle line, is not thus clothed.

The External Ear.

The external lobe of the ear, or *auricle*,* seems to be a natural completion of the face. As the latter, in its larger dimensions, has its hollows and prominences, so the smaller organ has its curves and undulations and elevations. The largest and deepest depression, a little below the middle of the lobe and immediately behind the pit of the auditory canal, is called the *concha*;† the semicircular projecting piece in front of the canal, and overhanging it, is the *tragus*.‡

Auricle.

Concha.

From above the tragus springs the characteristic incurved ridge, the *helix*,§ which defines the outline of the ear, projecting inwards in some parts as a ledge, in others as a scroll, and proceeding with a somewhat sinuous outline upwards, then transversely, and then again downwards till it gets below the level of the auditory opening, where it is lost in the dependent part of the ear called the *lobule*.

Helix.

Close within the helix, at its hinder part, is a prominence; which, however, diverges from it above, and forms the upper boundary of the concha, as well as giving rise to a smaller ridge extending to the top and front part of the lobe. This is the *antihelix*.

Antihelix.

Nearly the whole ear-lobe is of a very firm and hard texture; but some parts of the helix, together with the whole of the lobule, are quite flexible. The attachment of the lobe to the side of the head is in front just above the commencement of the helix, then passing round beneath the middle of the concha and coming down again to the bottom of the tragus. Thus the greater part of the concha, with the helix, antihelix, and lobule, are free from close contact with the head. Consequently the ear is found projecting in very various degrees from the side of the head behind.

Lobule flexible.

Attachment of ear-lobe.

We find a deep groove behind the ear, especially in the region of the deepest part of the concha; and next behind this may be easily felt a prominent convexity of bone, which is an important anatomical landmark; it is the *mastoid* ‖ *process* of the temporal bone.

Mastoid process.

The Mouth.

We have already described the lips, so far as they enter into the face and belong to the agencies of expression. But inasmuch as the mouth is an internal part which can be examined to a considerable extent from the outside, we must devote some space to it here, leaving some further details to be mentioned when we speak of its functions in relation to mastication and digestion.

The mouth is a cavity of some size, which is marked out by the presence of the teeth into two portions; we may call them respectively the cheek-cavity and the tongue-cavity. The former contains the internal lips, and the outer surfaces of the gums and teeth; the latter, the internal gums, the hard and the soft palate, and the tongue. The mouth as a whole is bounded behind by the throat.

Divisions: (1) cheek-cavity, (2) tongue-cavity.

The peculiar structure of the mouth depends first upon the almost vertical position of the *alveolar** portions of the upper and lower jaws. These form two corresponding arches of a long elliptical shape, the hinder part of the ellipse being absent. The teeth project from their sockets vertically to meet one another, and do so when the mouth is closed—that is, when the lower jaw is elevated so as to touch the upper; then the outer is so far separated from the inner cavity that only fluids can pass from one to the other.

Dental arches.

The alveoli are covered with a red mucous membrane, like the rest of the mouth; but there is beneath it a hard, firm tissue, so that the whole together constitutes the *gums*.

* Latin *aures*, the ears. + Lat. *concha*, a hollow.
‡ Greek *tragus*, a goat, in allusion to the supposed resemblance of the tuft of hair some persons have on this part to a goat's beard. § Greek *helix*, a spiral.
‖ *Mastoid*, nipple-like; Greek *mastos*, a nipple, from a supposed resemblance of this part in the dried skeleton to a nipple.

XLIX.

Exercise on the foregoing Study, for Translation into German, to be corrected by the German Version appended.

It is told that Beauty once asked the God Jupiter why she was so transitory, and that Jupiter replied, "Only what is transitory have I made beautiful." When love, and the flowers, and the dew, and youth heard these words, they all wept; for they knew that they were beautiful, and that they therefore would pass away. To the man who works, and who can wait patiently, life will bring its fruits; but the fruits of life are seldom fresh and beautiful, like those of the trees and of the fields. A child can find pleasure in a ball that it throws against the wall, and catches again; but the grown man acquires a friend who will throw the ball of wit back to him, if the game is to give (make) him pleasure. Worthy men are like stars in this dark world: they gleam, and show us where heaven is; and, like the stars, they are everywhere distributed through the great space. What a book has taught us, what

* *Alveolar*, socket-bearing: Latin *alveolus*, a socket.

a friend has told us, we may easily forget; but what we have learnt from the experience of life we always keep; therefore one may with truth say, "Believe life." Every man can be useful in life; the small (man) may fulfil his duty just as well as the great (man) on his path in life. One finds everywhere enough to do; and not the great and highly-placed men alone are they (it) through whom the world can win in worth. A true prince is he who knows how to rule. If he does not possess this talent, no man can be a prince in the higher sense of the word. Gustavus Adolphus said that he who understood best how to govern ought to be ruler and king.

German Version of the above.

Es wird erzählt (gesagt) daß die
ess virt er-tsaylt' ge-zahgt' dass dee
Schönheit einmal den Gott Jupiter
shöhn'-hite ine'-mahl dane gott yoo'-pit-ter
fragte warum Sie so vergänglich
frahch'-te vah'-room zee zo ver-geng'-lich
wäre, und daß Jupiter antwortete:
vair-reh unt dass yoo'-pit-ter ant'-vor-teh-te
„Nur was vergänglich ist, habe ich
noor vass fer-geng'-lich ist hah'-be ieh
schön gemacht." Als die Liebe, und die
shöhn ge-macht' als dee lee'-be unt dee
Blumen, und der Thau und die
bloom'-en unt dare tow (=now) *unt dee*
Jugend diese Worte vernahmen, weinten
yoo'-gent dee'-ze vorr'-te fer-nah'-men vine'-ten
sie alle; denn sie wußten daß sie schön
zee al'-le denn zee vuss'-ten dass zee shöhn
waren und daß sie daher vergehen
vah'-ren unt dass zee dah-hare' fer-gay'-en
müßten. Demjenigen (Manne) der
müss'-ten dame-yay'-nieh-en man'-ne dare
arbeitet, und der geduldig warten
arr'-by-tet unt dare ge-dool'-dich varr'-ten
kann, wird das Leben seine Früchte
kann virt dass lay'-ben zy'-ne früch'-te
bringen; aber die Früchte des Lebens
bring'-en ah'-ber dee früch'-te dess lay'-bens
sind selten frisch und schön wie diejenigen
zint zel'-ten frish unt shöhn vee dee-yay'-nich-en
der Bäume und der Felder. Ein Kind
dare boy'-meh unt dare fell'-der ine kint
kann Vergnügen an einem Ball finden,
kann fer-gnü-gen an i'-nem ball finn'-den
den es gegen die Wand wirft und
dane ess gay'-gen dee vand virrft unt
wieder fängt; aber der erwachsene Mann
vee'-der fengt ah'-ber dare er-vach'-sene mann
braucht einen Freund, der ihm den Ball
browcht i'-nen froind dare eem dane ball
des Witzes wieder zurück wirft, wenn
des vit'-ses vee'-der tsoo-rück virrft venn
das Spiel ihm Vergnügen machen soll.
dass speel eem fer-gnü'-gen mach'-en zoll.
Würdige Männer sind wie Sterne in
vuer'-di-ehe men-ner zint vee stairr'-ne in
dieser dunklen Welt; sie leuchten, und
dee'-zer doonk'-len velt zee loieh'-ten unt
zeigen uns, wo der Himmel ist; und wie
tsy'-chen oons vo dare him'-mel ist unt vee
die Sterne sind sie überall durch den
dee stairr'-ne zint zee üh'-ber-all doorch dane
großen Raum vertheilt. Was ein Buch uns
gross'-en rowm fer-tihlt' vass ine booch oons
gelehrt hat, was ein Freund uns gesagt
ge-layrrt' hat vass ine froint oons ge-sahcht
hat, können wir leicht vergeßen; aber
hat kön'-nen veer lycht fer-ges'-sen ah'-berr
was wir von der Erfahrung des Lebens
vass veer fon dare er-fah'-roong dess lay'-bens
gelernt haben behalten wir immer;
ge-lerrnt' hah'-ben be-hall'-ten veer im'-mer
daher kann man mit Wahrheit sagen;
dah-hare' kan man mit vahr'-hite zah'-gen
„Glaube dem Leben." Jeder Mann
glow'-be dame lay'-ben yay'-derr mann
kann im Leben nützlich seyn; der Kleine
kann im lay'-ben nütz'-lich zine dare kly'-ne
findet überall genug zu thun; und
finn'-det üh'-ber-all ge-nooch' tsoo toon unt
nicht die großen und hochgestellten
nicht dee gross'-en unt hoch'-ge-stell-ten
Männer allein sind es, durch welche die
men'-ner al-line zint ess doorch vel'-che dee
Welt an Werth gewinnen kann. Ein wahrer
velt an vairt ge-vin'-nen kann ine vah'-rer
Fürst ist derjenige welcher zu
fuerst ist dare-yay'-nich-e vel'-cher tsoo
herrschen weiß. Wenn er nicht dieses
herr'-shen vice venn air nicht dee'-zes
Talent besitzt kann kein Mann ein Fürst
tah'-lent be-zitst' kann kine man ine fuerst
in dem höheren Sinne des Wortes seyn.
in dame höh'-er-en zin'-ne des vort'-es zine
Gustav Adolf sagte daß der welcher
goos'-taf ah-dolf zaach'-te dass dare vel'-cher
am besten zu herrschen verstehe Herrscher
am best'-en tsoo herr'-shen fer-stay'-e herr'-sher
und König seyn sollte.
unt köh'-nich zine zoll'-te

XIV.

NORTH AMERICA.

THIS great division of the world comprehends all that part of the American continent or New World lying north of the Isthmus of Panama, between lat. 8° and 80° N., and long. 54° and 166° W. It is bounded on the north by the Arctic Ocean, west by the Pacific Ocean, south by the Pacific Ocean, the Isthmus of Panama, and the Gulf of Mexico, and east by the Atlantic Ocean. Including Greenland and the numerous islands, it has an area of about 8,325,000 square miles. The coasts are extremely irregular, being deeply indented by gulfs, bays, and arms of the sea. This is par-

ticularly the case with the east coast, where occur Davis' Strait and Baffin's Bay, Hudson's Strait and Hudson's Bay, Gulf of St. Lawrence, Gulf of Mexico, and Gulf of Honduras. On the west coast are the Gulf of California, Bay of San Francisco, numerous small bays and sounds of the British territory; and north of this, Prince William's Sound, Cook's Inlet, Bristol Bay, Norton's Sound, and Kotzebue Sound. The principal peninsulas are Labrador, Nova Scotia, Florida, Yucatan, Lower California, and Alaska. The coast line is estimated at about 24,000 miles in length. The most important islands are Greenland, Newfoundland, Prince Edward, Cape Breton, the West Indies, and Vancouver.

The Andes of South America may be regarded as continued in a greatly diminished form through the Isthmus of Panama; and a chain, which may be considered as a continuation, rises almost immediately thereafter, and running north-west, spreads out in Mexico into extensive table-lands, towered over by lofty volcanic peaks, of which that of Popocatepetl, near the city of Mexico, is 17,783 feet high. Further north this chain forms the Rocky Mountains, which attain their greatest height in Mount Hooker, in British Columbia, 16,760 feet high; but afterwards gradually diminish and terminate on the Arctic Ocean. West of the Rocky Mountains there are several other chains which run parallel to them. One of these, the Sierra Nevada of California, proceeds northward through Oregon, Washington, and British Columbia, and with decreasing elevation is continued northward, till passing through Alaska it terminates at Behring Strait. The Coast Range extends from the peninsula of California, along the coast, continuously as far as Vancouver Island, but afterwards with interruptions, and at length terminates in the Alaska peninsula. North of lat. 60° N. is the active volcano of St. Elias, said to be over 17,000 feet high. East of the Rocky Mountains, the great central region of North America, from the shores of the Arctic Ocean to the Gulf of Mexico, is low and flat, with no elevations of more than 1500 or 1600 feet above the sea. Towards the east the country again rises, but the heights on the Atlantic side are far inferior to those on the Pacific. The Alleghany or Appalachian Mountains extend from about lat. 34° N. to the banks of the St. Lawrence. The general direction is from south-west to north-east, and the highest point is the Black Mountain, in North Carolina, 6700 feet. Many of the rivers of North America are of great extent. The Mississippi, if we consider the Missouri as its main branch, is the longest river in the world, being about 4300 miles in length. The Missouri rises in the Rocky Mountains, and has a course of about 3100 miles before it joins the Mississippi, which, rising in some small lakes west of Lake Superior, conveys a larger volume of water though its course is much shorter. The united stream, after receiving the Ohio from the east and the Arkansas and Red River from the west, falls into the Gulf of Mexico. The Rio Grande del Norte is the next in size of the rivers falling into the Gulf of Mexico. The St. Lawrence, which falls into the gulf of the same name in the Atlantic, rises under the name of St. Louis, and flows through Lakes Superior, Huron, Erie, and Ontario, having a length of about 2100 miles. Between Lakes Erie and Ontario are the celebrated Falls of Niagara, where the water is precipitated over a ledge of rocks 160 feet high. The Mackenzie River flows northward, and falls into the Arctic Ocean, east of the Rocky Mountains, after a course of about 1600 miles. The rivers falling into the Pacific are mostly of small size, the principal being the Yukon in Alaska, the Columbia, and the Colorado. The principal lakes, with their areas in square miles, are—Superior, 32,000; Huron, 30,000; Michigan, 22,000; Great Bear, 14,000; Great Slave, 12,000; Winnipeg, 10,000; Erie, 9600; Ontario, 6300; Great Salt, 2000. As a rule, the average temperature of North America is lower than in the corresponding latitudes of the Old World. The average temperature on the western side is also considerably higher than on the eastern—to the extent sometimes of six or seven degrees. The north-west territories east of the Rocky Mountains are cold and inhospitable, and not suited for agriculture. Towards the south the climate of course becomes much warmer, till in Mexico it is essentially tropical, though even here, on the table-lands and mountains, it is temperate or even cold. North America is celebrated for the richness and variety of its mineral productions, including gold, silver, lead, tin, iron, mercury, coal, petroleum, sulphur, salt, etc. Gold is found in California, British Columbia, and Mexico; silver in Mexico, Central America, California, and Canada; copper in Canada, especially in the vicinity of Lake Superior, which is one of the richest copper regions in the world. Coal and iron are widely diffused. The Appalachian coal-field is of great extent; and there are also extensive deposits in Nova Scotia, Vancouver

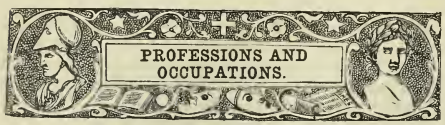
THE GRASS-HUTS, ETC., OF THE KAIVAVAS.

Island, British Columbia, etc. Iron is found in many parts of the United States, in Mexico, and in Central America. The forests are of vast extent. In the northern zone they consist chiefly of pine, oak, ash, beech, birch, cedar, poplar. In the middle zone the prevailing trees are the sycamore, chestnut, walnut, hickory, maple, etc.; while in the south they include the mahogany and other valuable woods, and attain an enormous size. Maize, cocoa, vanilla, and tobacco are indigenous; wheat, barley, oats, peas, and beans succeed well; while sugar, coffee, cotton, and rice, are among the staple productions of the southern sections. The vine, orange, peach, plum, apple, etc., are largely cultivated. Among the wild animals the most distinguished are the grisly and polar bears, musk ox, bison or American buffalo, moose and reindeer, wolf, fox, beaver, otter, racoon, opossum, squirrel. Reptiles are numerous, and many of them poisonous. Among the birds are eagles, vultures, hawks, owls, and numerous species of water-fowl. In Mexico and Central America the aborigines still form a large portion of the population; but in Canada and the United States they are now comparatively few. They are of an olive-brown or copper colour, moderately tall, robust, and well-proportioned, with nose large and often aquiline, cheek-bones large and prominent, forehead low and broad, eyes small, black, and deep-set, hair long, coarse, and black, and beard thin.

BURYING-PLACE, HUTS, AND BUFFALO DANCE OF THE MANDANS.

British North America.

British North America comprises (with the exception of the territory of Alaska, which belongs to the United States) the whole of the northern portion of this continent from the Arctic Ocean to the 49th parallel of north latitude, the line of the St. Lawrence, and in the lower part of its course both sides of that river. It extends from the Pacific Ocean and Alaska on the west to the Atlantic Ocean on the east, and has an area of 3,205,330 square miles, or nearly as much as the whole of Europe. Only a small portion of this territory, however, is inhabited, by far the greater portion of it being too sterile and the climate too severe to admit of cultivation. The population in 1881 only amounted to 4,352,080. It includes the several provinces of Ontario and Quebec (formerly Upper and Lower Canada), New Brunswick, Nova Scotia, Manitoba, Prince Edward Island, British Columbia, and the North-West Territory (formerly the Hudson Bay Company's Territory), which have been united under one government and styled the "Dominion of Canada." The climate is characterised by great heat in summer and severe cold in winter. Extensive forests and prairies occupy a great part of the surface. The cleared districts have, in general, a very fertile soil, yielding abundant crops of grain and other products. The chief industries are agriculture, stock-raising, and dairy-farming, the timber trade, fisheries, and mining. The fisheries along the coasts are very valuable. The mineral wealth is considerable, including gold in British Columbia, copper, especially in the neighbourhood of Lake Superior, iron, coal, lead, zinc, petroleum, etc. In the North-West Territory fur-bearing animals, as foxes, wolves, beavers, bears, and otters, are common. The principal exports are timber, fish, furs, dairy produce, live stock, and dead meat. In 1880 the total exports were £18,063,973, of which to the United Kingdom £13,388,988; the imports £17,734,454, of which from the United Kingdom £8,516,019. The river St. Lawrence is navigable for the largest vessels to Montreal, nearly 600 miles from the sea. The course of the river above this is obstructed by falls and rapids, but the navigation is continued by canals, so as to open up communication with the Lakes Ontario, Erie, Huron, Michigan, and Superior. The construction of the Canadian Pacific Railway, which is to connect the Atlantic and Pacific coasts through British territory, will doubtless be of great benefit to the country. The executive power is vested in the Queen, and exercised in her name by a Governor-General, aided by a privy council. The legislative power is exercised by a parliament consisting of a senate of 77 members, nominated by the executive, and a house of commons of 206 members, elected by the people for five years. Each province has a separate parliament, and administers its own internal affairs under a Lieutenant-Governor appointed by the Governor-General. In 1881 the public revenue was £6,105,210; expenditure, £5,255,972; and public debt, £32,248,408. The capital is Ottawa, in the province of Ontario, with 27,417 inhabitants; but the largest city is Montreal, in the province of Quebec, with 140,862, followed by Toronto, the capital of Ontario, with 86,455, and Quebec, the capital of the province of that name, with 62,446 inhabitants; the next in size is Halifax, the capital of Nova Scotia, with 36,102 inhabitants.



III.

Mechanical Occupations.

In our previous articles we have given hints as to the advisability of considering a lad's mental and physical qualifications for a certain trade before finally deciding upon it as his life-work. Let us now briefly glance at some of the more important trades, not attempting, however, any elaborate classification, but taking them pretty indiscriminately.

First we have the important group comprehending what are known as the "building trades"—including masonry, bricklaying, carpentry, joinery, painting, plumbing and glazing. These are trades which cannot fail always to be in universal request. The rule of apprenticeship differs much amongst them. In some (as the plumber's) the seven-years apprenticeship is kept up; in others three or four years is held sufficient; and in many instances apprenticeship is altogether dispensed with, the boy being taken on at a low wage, to help, and gradually acquiring the trade. The wages in most of the trades in London is 33*s.* per week (£2 and upwards on piece-work). In the country wages are so variable that it is impossible to give any fixed sum. In remote rural villages they may sink as low as 16*s.* per week, and in prosperous country towns rise as high as the metropolitan standard. Of course in the country the piece-work also is less remunerative than in London, and ornamental masonry, brickwork, or joinery, is seldom required.

Of late years the building trades in large towns, especially in London, have offered more favourable opportunity of rising in the world than most others. A man, let him be carpenter, bricklayer, mason, or what not, who understands the routine and prices of the details of house erection, saves a few pounds and begins to contract for small repairs. Succeeding at this he ventures on contracts for small houses, and becomes a master and employer of labour. By-and-by, whether by building society or otherwise, he gets possession of some leasehold land (that in London is generally held for ninety-nine years at a small ground rent, the houses at the expiration of the lease becoming the ground landlord's); then the foundations are excavated, and the brickwork erected. Upon these "carcases," as the outer walls are termed, the builders can generally borrow sufficient money to fit up and complete the buildings, and many a journeyman has thus blossomed into a "speculative builder," and ended as a wealthy landlord.

The various arts connected with the production and supply of food need not come under our purview, as not "mechanical." Agriculture has been treated in another paper; and such trades as the butcher, greengrocer, and fishmonger and fruiterer, not demanding much manual skill, are less well paid than those connected with building, and do not generally demand apprenticeship, the errand boy gradually being brought into the trade. Baking (a most unhealthy and fatiguing business) is underpaid, the competition of German immigrants being very formidable.

With regard to trades connected with clothing, we do not purpose to speak of the few male hands employed in cotton and woollen mills, but the crafts of the tailor and shoemaker may be mentioned as always in request, and yielding fairly good wages. Apprenticeships are still the rule. The former trade in larger towns, where the "sweating" system prevails, is extremely unhealthy and unsatisfactory. Both are businesses which will afford the careful workman good opportunities of becoming his own master.

Printing, lithography, and bookbinding are trades yielding tolerably good wages,—say on an average 36*s.* per week, and more where piece-work rules. Apprenticeships prevail, but by no means universally. Compositors in newspaper offices make large earnings, but the work is carried on largely during the night, and is very debilitating. "Finishers" in bookbinding (the men who gild and letter the books) make good money if tasteful artisans, and always serve an apprenticeship, but the trade is limited. Work fluctuates much, and is often scarce, in all branches of the printing trades.

Wood, steel, and copperplate engraving are well-paid trades, to which apprenticeship is generally required. A lad should have some artistic taste and skill in drawing who is selected for them.

Watchmaking and jewellery are tolerably good trades, to which apprenticeship is an almost indispensable preliminary. Watchmaking has deteriorated of late years.

Engineering is a very popular and profitable business. Wages are good,—about 40*s.* per week,—but often ranging far above that for special piece-work. Apprenticeship is the rule, but it does not prevail everywhere. Iron shipbuilding falls in the same category. Blacksmithing, whitesmithing, the art of the coppersmith and pewterer, are all fairly good, but laborious and unpleasant businesses. In country villages the smith is mostly the principal tradesman. Wages very variable.

Saddlers, harness-makers, and collar-makers are indispensable even in the smallest country place. In large towns they are very prosperous and well-paid trades, ranging from 36*s.* per week upwards. We have known makers of ladies' saddles in a West End shop who could earn on the piece from £6 to £8 per week. Of course this was exceptional. It is a clean and pleasant trade.

The makers of musical instruments are a class apart, and wages differ so much that they cannot be formulated.

The cabinet and upholstery trades are generally acquired by a course of apprenticeship. The wages are usually tolerably good.

The wheelwright generally ranks in villages

and small provincial towns as next in importance to the smith. The carriage-building in large towns is divided into many branches. Amongst woodworkers, those who make the bodies are generally distinct from the wheelers. Then there are the smiths, and spring-makers, the painters, the trimmers, and the herald painters. Apprenticeship is general, and wages range from £2 upwards.

The English workman suffers from periods of bad trade and slackness to a greater extent than some of his Continental *confrères*. For example, it is by no means unusual for a French *ouvrier* to have a couple of trades at his fingers' ends. The use of this is very obvious. In a very interesting record of personal experience, entitled "The Working Man's Way in the World," an example of this is adduced. The author (a compositor) tells of one of his companions, a gay, light-hearted young Frenchman with whom he had fraternized. By-and-by work became scarce at the printing-office (the well-known *Galignani's*), and both the English and the French *employés* were on half time. To relieve the tedium of these vacant hours the Briton strolled about improving his acquaintance with the fair city. Happening to pass a saddler's shop, his eyes fell upon the row of busy workmen seated in the window (a custom of the trade), when whom should he see but his friend Jules, merrily stitching away at the pig-skin! It would probably be impracticable to adopt this plan in our country, but the advantages of it are unquestionable.

In a great empire like ours, peopled by an active race, almost every youthful or adult citizen may look forward to the fairly probable contingency that future circumstances may induce him to quit his sea-girt birthplace for some portion of "Greater Britain,"—and in that event, the man who is master of a good mechanical trade has immense advantages over others. This is especially true of members of the building trades.

And here let us say that, although not generally advising the acquisition of two trades like the Parisian, we consider it wise for every working man to obtain some degree of dexterity in the use of carpenter's tools. It is impossible to overestimate the advantages of this knowledge, which most boys will readily pick up if only their parents will supply them with small tool-chests suited to their strength and capacity.

There is another matter to which a few lines may well be devoted. We do not doubt but that this page will fall under the eyes of many adult readers who are not satisfied with the craft to which circumstances have tied them, and will say regretfully, "Ah, when I was a boy there was no choice left to a lad. My father selected my line for me, and I have hated it all my life." We have met many men to whose lips such complaints were familiar, and who would attribute their non-success in the battle of life to this fact. In other cases they may have been allowed the choice, and fancy now they have chosen wrongly. This repining should never be cherished. Every trade has its own pleasures and chances, if honestly sought. Every trade also has its bitterness and disappointments. We must all suffer

> "The panting breath, and hurrying steps of life,
> The sights, the sounds, the struggle, and the strife
> Of hourly being; the sharp, biting file
> Of action fretting on the tightened chain
> Of rough existence."

This feeling should be valiantly striven against, or it will become destructive of all true manliness. Says a sensible counsellor:—

Although the utmost care should be taken in selecting an employment that shall, if possible, be congenial to the taste, it is quite essential that this alone should not be depended upon for success. Often the one that promises the most, in this respect, disappoints us most in its actual working. Perhaps we mistook fancy for fitness; perhaps we are fickle, and grow weary of one thing, and long for changes; perhaps we have not counted on the hard work which every worthy employment demands. Whatever be the cause, it is certain that in very frequent instances our daily employments are not at all what we should choose if we were free to choose now. Either we dislike them, or, what is much the same, we like something else so much better, that by comparison our own work seems disagreeable and hard. Where this is not the permanent condition, there will yet be seasons when this state of mind arises,—times when our regular business seems dull, tiresome, and flat, and when we droop over the task.

No one can do heartily what he dislikes, any more than he can eat heartily of food that is nauseous to him. It is not in nature to put heart, energy, and enthusiasm into anything positively disagreeable. An urgent necessity may compel the actual performance of the unpleasant work; but even then it is never done in the best way, and the chances are that it will be a feeble and valueless affair. It may be said that if this is true, all idleness and languor are excusable, and that it only remains to change the occupation until one can be found that shall be in all respects congenial. Yet this by no means follows, for although our work may at present be distasteful, it need not *remain* so. There is a power within each of us, which, if strongly and continuously exercised, can change the disagreeable first to the tolerable, and then to the actually agreeable.

We have first to inquire if this work really belongs to us. In the majority of cases the true answer will be found in the affirmative. Education, training, circumstances, and perhaps our own unbiassed choice, have placed us here, and given us this special task to perform. We *can* do it; perhaps there is nothing else we can do so well, perhaps there is nothing else open to us to do. Except in rare instances duty and prudence call upon us to continue in our present sphere of labour. If this be so, however, then they equally call upon us to make that sphere an agreeable one. This is not the impossible task that it may appear. All effort is at first painful; but perseverance makes it easy, and at length it becomes a chief element of happiness. The real wrong of

idleness, languor, and half-heartedness is the refusal to accept this discipline. Let any one who experiences this distaste to his daily toil, set resolutely to work to conquer it. Let him first avoid all outward expression of his repugnance and seeming to claim sympathy for it; as this can but serve to increase it, and weaken his own power to subdue it. Let him then day by day labour assiduously and perseveringly, forcing himself to do so if necessary, bringing all his powers to bear upon it, searching for improved methods, and welcoming all the light which modern science or his own unfolding faculties can give to enable him to perform it in the best, most thorough, and most speedy manner. Let him do this, not spasmodically, but steadily, constantly, firmly, day by day and week by week, and he will find—no sudden and startling change indeed, but a gradual growth of interest and awakening of attention within himself; he will discover far more to engage his thoughts and arouse his energies than he conceived possible; and by degrees he will learn to like and even to prefer the occupation that once so painfully excited his repugnance.

In conclusion, it is to be hoped that the spread of technical education will enable all classes to better understand the various trades extant amongst us, and render a good selection more easy alike to parent and child. Every one should gain some general mechanical knowledge sufficient to rationally comprehend the *modus operandi* of all the great trades. This will not only tend to general intellectual enlargement, but will enable every one to pursue his special trade more advantageously.

MASSINISSA.

XLIV.

Rome (*continued*).

After twenty-two years of peace the second Punic war broke out. It was one of the most remarkable wars Rome was ever engaged in, and never perhaps was she so near destruction. The Carthaginians were led by a man who by common consent is acknowledged to have been perhaps the greatest commander that has ever appeared in Europe. The genius of even Alexander the Great pales before that of Hannibal. Napoleon, whose exploits in some respects resembled Hannibal's, is the only general that we know of worthy to be compared with him.

Second Punic war, B.C. 219.

Hannibal.

When a boy Hannibal was made by his father to swear eternal hatred to Rome, and he never forgot his oath. At the age of twenty-six he became general of the Carthaginian army in Spain, and soon managed to provoke the Romans to war. His plan was to march his army by land from Spain into Italy, where he hoped the Italian tribes recently conquered by Rome would join him in the hope of getting free from Rome. But to get into Italy he had to cross first the Pyrenees, then the Rhone, and finally the Alps. No such feat had ever before been attempted; and even in our own century it was considered one of Napoleon's greatest exploits to have crossed the Alps, with all the aid of modern engineering science. With marvellous quickness and skill, Hannibal, with a force of 50,000 foot, 9,000 horse, and 37 elephants, crossed the Pyrenees and the Rhone, his passage of the river being disputed by the Gauls. Then he marched on to the Alps, where the difficulties which faced him might well have made him pause. The mountaineers rolled down great stones on his men, and attacked them whenever they caught them at a disadvantage. Men and horses and elephants died in thousands from cold and fatigue. It was late in autumn, and the passes, difficult in midsummer, were now covered deep with snow. Still he pressed on, and at last the other side was gained; but at what a cost! His 50,000 foot were reduced to 20,000; 3000 of his horses were missing; and only seven out of his thirty-seven elephants remained. But now he hoped the Gauls would join him against their conquerors. Bitter was his disappointment at finding that neither Gauls nor any other people would come to his assistance. His hopes revived, however, as soon as the Romans ventured to meet him. This they did at the river Ticinus. Hannibal was victorious, and continued his march southwards. Again the Romans with fresh forces attempted to stop him at the river Trebia, but again they were beaten, and Hannibal was master of all Northern Italy.

Passage of the Alps.

Hannibal's victories.

But the Gauls of North Italy, though friendly to him, did not flock to his standard as readily as he expected, nor did the lately conquered Italians further south.

Early in the next year, 217, he continued his march southwards; and the Romans plucked up courage to oppose him at Lake Trasimenus, but for the third time received a crushing defeat. The senate were now thoroughly alarmed,—indeed there was cause, for Hannibal had proved himself more than a match for any army the Romans had as yet mustered against him, and at the present juncture there was no army between him and Rome.

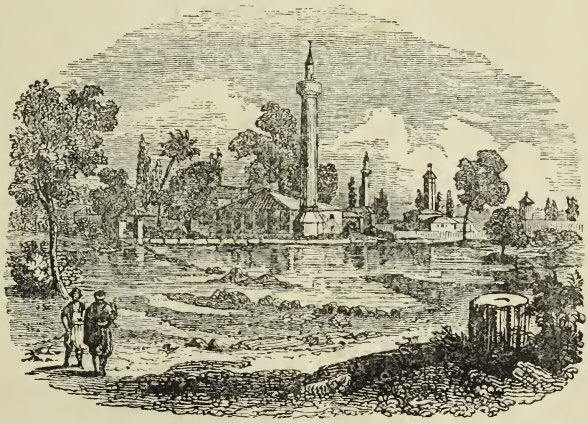
Battle of Lake Trasimenus.

The senate determined to appoint a dictator, and their choice fell on Fabius Maximus, whose policy was to hang round and watch for opportunities of embarrassing Hannibal without giving him a chance of again defeating them in a pitched battle. This policy came to be called a "Fabian" policy, and its author received the soubriquet of "Cunctator," or the Delayer. This policy was excellent so far as Rome alone was concerned, but it was ruinous to her allies the Italians, whose lands and towns were exposed to the merciless ravages of the Carthaginians. So at last the Consul Varro, with an army nearly double that of Hannibal, ventured to attack him at Cannæ, B.C. 216; and for the fourth time the Roman army was almost annihilated. Some accounts say that 45,000 Romans fell, but other accounts give the number as 70,000! This appears incredible; but at all events we may be sure the carnage was appalling, and the blow well-nigh fatal to the cause of Rome. Had the Latin cities and the Roman colonies scattered over Italy embraced this chance of freeing themselves from Rome, as Hannibal had calculated they would, or had they even remained neutral, Rome must have gone down before the genius of the wonderful man who was now redeeming his boyish oath of implacable hostility towards her. But though he could beat every army that ventured to meet him, he could not subdue the towns, except after long sieges, and to overcome so many would have been a work of many years, and required fresh reinforcements. But no reinforcements arrived. The Carthaginian senate were jealous and ignorant, and would not send him more soldiers. His brother Hasdrubal in Spain would gladly have come to his aid, had not the Romans taken good care to give him plenty of occupation there. For several years Hannibal marched where he liked, now and then taking a town, but generally losing it when he marched somewhere else; never venturing to attack the city of Rome itself, and never getting a chance of destroying a Roman army in a pitched battle. But in 207 Hannibal's last hope failed him. His brother Hasdrubal, giving the slip to the Romans in Spain, made his way into Italy by the route his brother had taken eleven years before, bringing a considerable reinforcement with him. He sent messengers to tell his brother of his coming; but the messengers fell into the hands of the Roman commander Nero, who, hastily uniting his own forces with those of the consul who was pursuing Hasdrubal, fell on the latter unexpectedly, and killed him, along with the greater part of his army, on the banks of the river Metaurus.

Fabius dictator.

Battle of Cannæ B.C. 216.

Hasdrubal.



HYPERIAN FOUNTAINS.

Hannibal knew nothing of his brother's being in Italy until a bloody head was thrown into his camp, and recognized as Hasdrubal's. We can hardly estimate the overwhelming effect of this event on the Carthaginian. Succour and sympathy from beyond the seas were no longer to be hoped for, and it must have been evident to him that the great enterprise on which for the last eleven years his incomparable military genius had been concentrated, and on which he had staked everything, was simply hopeless. Still he held his ground for four years more in Italy. The Romans were by no means eager to provoke him to action, and he was so dispirited that he seems to have attempted very little.

Hannibal's despair.

But meantime the Romans, led by Scipio, had completely driven out the Carthaginians from Spain. Emboldened by his success, Scipio induced the senate to let him take an army into Africa, there to attack the Carthaginians in their own country. In 204 he landed, and shortly after gained a victory over the African forces. This decided the senate of Carthage to send for Hannibal to come home and defend his own country, now in its turn invaded and in peril. Obedient to this order, and perhaps recognizing the hopelessness of further attempts, Hannibal at last sailed away from the country where for seventeen years he had, without aid from abroad, maintained himself against the whole strength of Rome, and crushed every army that dared to face him openly. Nearly a year passed before he and Scipio met, but at last, in B.C. 202, they did meet. A great battle was fought at Zama, and Hannibal, for the first time in his life, was beaten, and had even to fly for his life, while almost his whole host was destroyed. This decided the war, and made further resistance on the part of Carthage impossible. Peace was made, by which Carthage handed over to her rival her whole navy, a large sum of money, and one hundred noble hostages, and agreed to make no war even in Africa

Hannibal leaves Italy.

Great battle at Zama, B.C. 202.

Peace with Carthage.

without the consent of Rome. For these terms, hard as they were, she had to thank Scipio, whose whole influence was exerted on the side of generosity towards the conquered nation, and who probably preserved Carthage from the total destruction which many people at Rome wished to see.

Hannibal was obliged to go into exile, but the enmity of Rome pursued him wherever he went, and no nation cared to bring down Rome's wrath by harbouring her deadly enemy. Hunted from country to country, he at last took poison, to avoid being taken by the Romans, B.C. 183. His life was a failure. He had attempted a task beyond the means at his command. Hannibal was stronger than any general opposed to him, but Carthage was no match for Rome. His grand miscalculation was in supposing that he could unite the Italian races against Rome, and his failure to do this rendered fruitless the magnificent victories of Trasimenus and Cannæ.

End of Hannibal.

On Scipio honours and rewards were poured without stint, and he received the special honour of a surname derived from the country he had conquered. Henceforth he is called Scipio Africanus.

The effects of this great war were of immense importance. By the destruction of her greatest rival, Rome became the most powerful of all the countries round the Mediterranean, besides adding Spain and Carthage to her empire. But the ill effect of the war was the change of Rome's policy towards the Italian cities. All who had joined Hannibal were treated with the greatest severity, and even their brethren who had remained faithful to Rome were gradually placed in the same category, and saw their hopes of soon being admitted to the privileges of citizens again disappointed.

Effects of the Punic Wars.

For the next half-century the aggressive energy of Rome was chiefly occupied in conquering the East, which, after Alexander the Great's death, had split up into a number of independent kingdoms, of which the principal were Macedonia (including Greece) Syria (including Asia Minor), and Egypt.

Conquest of the East.

The Grecian provinces of Macedonia were the first to fall under Roman sway, after a sharp struggle. Syria soon followed, bringing with her the subject states of Asia Minor. These conquests were made with comparative ease, and the power of Rome over the conquered countries of the East was gradually strengthened and consolidated. The final conquest of Spain was a more difficult matter.

We have seen that Scipio had, after an obstinate struggle, driven out the Carthaginians. But the natives continued to fight on against the Roman generals. The taking of the town of Numantia, in B.C. 123, was the final act in the Roman conquest of Spain, and it was effected only by starvation, after the chief citizens had killed themselves rather than surrender. Henceforth Spain remained a province of Rome until the Northern barbarians in the decline of the Roman Empire wrested it from her.

Final conquest of Spain.

As for Carthage, the Romans seemed to feel that they had "scotched the snake, not killed it," and they were anxious for a pretext to complete the destruction of this dreaded enemy. They were not over-scrupulous in making a pretext. At first Carthage submitted to the insolent demands of Rome, and gave up all that was demanded, including a number of noble hostages, and even all their arms. The Carthaginians, being now defenceless, Rome desired them to pull down their city and rebuild it ten miles inland! This was too much for a people whose only resource was trade. They saw that their utter destruction was determined on, and, disarmed as they were, they decided to strike one blow yet. They set to work with the energy of despair to prepare for a siege. New arms were made somehow or other, the women cutting off their long hair to be woven into bow-strings. Animated by such a spirit, their resistance was obstinate and bloody. It took the Romans three years to reduce the city of Carthage, and when at last they got into the city, they had to fight from house to house until nine in every ten of the inhabitants had fallen. Then the city was burned to the ground, her name was blotted out from the map, and her territory became a Roman province, under the name of Africa, B.C. 146.

Destruction of Carthage.

All the great countries bordering on the Mediterranean were now subject to Rome; and as these were almost all the civilized parts of the world known at that time, we may henceforth consider Rome as the mistress of the civilized world.

Rome, mistress of the civilized world.

III.

The Steam Engine (*continued*).

We have now to consider the boiler and fireplace of the locomotive; but if we pause first in order to inquire what is expected of this part of the engine, we shall probably be able the better to appreciate the means by which results are attained that were not very long ago thought absurdly impossible. For each revolution of the driving wheels it is necessary that the two cylinders shall each be twice filled with steam. Now, if the circumference of the driving wheels was $26\frac{4}{10}$ feet, they would have to revolve exactly 200 times for each mile passed over. But 200 revolutions require 800 cylinder-fulls of steam, and this quantity must be supplied every minute if the engine is going at the rate of 60 miles an hour. The amount of water necessary to furnish this steam it has been calculated would be from 12 to 20 gallons, the whole of which must be converted

into vapour within the minute. This enormous evaporating power is secured by the use of a tubular boiler—that is, one where the flame and heated gases from the furnace are caused to pass through a great number of tubes, which traverse the boiler from end to end, on their way to the chimney. These tubes are generally from 1½ to 2 inches in diameter, and may be regarded as subdivisions of the flue, the object being to increase as far as possible the surface of water heated, so that the transference of heat from the hot gases produced in the furnace to the water in the boiler may be as rapid and complete as possible. A section of a locomotive, showing the boiler tubes, is given in fig. 9.

One of the most important details in all furnaces is the production of a sufficient draught of air to maintain a rapid combustion of the fuel. In stationary engines this draught is generally obtained by the use of a high chimney, the upward rush of the hot gases, on account of their lightness, being quite sufficient for the purpose. But it would obviously be impossible for a locomotive to have a lofty chimney, not only because of the danger to the engine itself, but because of the limited height of the tunnels and bridges. The draught, therefore, has to be obtained in an artificial way, by discharging the spent steam through the blast-pipe into the chimney. The forcible rush of steam through the chimney sucks up the air with it; and this arrangement has the great advantage that it is automatic in its adjustment, for the more rapidly the engine works, the more frequent are the steam-blasts in the chimney; and the greater the volume of air drawn through the flues and fire-box, the greater is the quantity of steam produced; while if the steam is shut off from the engine the draught is practically stopped, and the combustion of fuel immediately moderated. The draught is further regulated by means of a damper placed in the lower part of the chimney, which is under the control of the engine-driver.

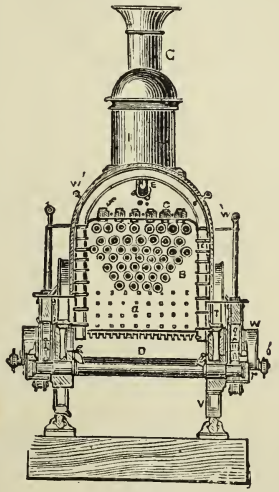


FIG. 9.

The pipe through which the steam passes to the cylinders does not terminate as soon as it gets inside the boiler, but passes along the top to the steam-chest, and then turns up so that its orifice may be as high as possible from the surface of the water, to prevent *priming*—that is, water being carried into it with the steam. The *steam-chest*, or *receiver*, is generally dome-shaped, and situated about the middle of the boiler. The *safety-valve* is a taper plug that accurately fits a hole in the top of the boiler, and is pressed down into it by springs so adjusted that if the pressure within the boiler exceeds a certain limit, it is sufficient to force open the valve, and so allow the steam to escape. In a machine so subject to changes of position as a locomotive, it is found impossible to use weights for the safety-valve, and therefore springs—though an inferior contrivance—have to be employed. The steam-whistle is shown in fig. 10. When in use, the steam escapes from the annular orifice, *d d*, and blows forcibly against the edge, *e e*, of the cap, *f*, and so produces the well-known penetrating noise.

Hydraulic Machinery.

There are various methods by which energy, that is, capability of doing work, may be stored, but perhaps the simplest of all is by the raising of ponderable matter from a lower to a higher level. To take an example, a cannon-ball or a block of stone that rests on the ground is a harmless and a powerless object, but if taken to the top of a tower, it is invested with an amount of energy that will remain latent so long as it is supported in that position, but which may be reproduced in an active form by allowing it to fall to its original level. The tremendous effects produced by heavy bodies falling from considerable heights are most substantial proofs that these bodies had power, and that that power has been made active.

The sun is practically the centre of power in the solar system, and in the ordinary course of nature there are many ways in which its energy is made available for the use of man. The utility of sunshine on the land is sufficiently evident, but the unthinking will perhaps be inclined to grudge the welcome warmth that is swallowed up by the ocean. There is, however, no loss here, even from the meanest utilitarian point of view, for the water is warmed and rises in invisible vapour to form the clouds, and is by this raising stored with an amount of energy that is not realized until we see the effects of the showers of rain or hail, or the concentrated power in a mountain torrent, or the still more mighty force of a flood that will sweep away trees, bridges, and even towns. This vast amount of energy is, under ordinary circumstances, entirely spent in altering the face of the earth, and in the reproduction of heat; but from the earliest times man has been accustomed to avail himself of this power by more or less simple mechanical contrivances, generally classed together as *hydraulic machinery*. This term also includes those machines that work by means of water that has been artificially raised, and those where the power is merely transmitted by means of water.

A fall of water may be made to perform useful work by a variety of methods. If, for instance, a rope that passes over a pulley has a pail attached to one end of it, and the pail is allowed to collect the water at the top of the fall, the water will press the pail downwards with a force sufficient to raise anything of equal

weight that is attached to the other end of the rope. Such an apparatus would be a simple hydraulic hoist. If the pail were fastened to the upper part of the rim of a large wheel, it would, as it filled with water, have a tendency to drag down that part of its circumference that it was attached to, and so turn the wheel; and this motion would be made continuous by securing several pails at different parts of the wheel's circumference. The *over-shot* water-wheel (*see* fig. 11) is such an apparatus, and is generally made of great width, that the chambers round its outer edge may be sufficiently capacious to hold a considerable weight of water. The wheel turns the shaft it is secured to, and the motion so obtained is communicated in the usual way to the machinery it is desired to drive. If the available stream has not the necessary fall, then advantage may be taken of the velocity of its flow by means of the *under-shot* water-wheel. The figure (12) is a sufficient explanation of its action; the water flowing in the direction of the arrow carries the floats that are immersed in it, and so turns the wheel in the same direction that the hands of a clock travel.

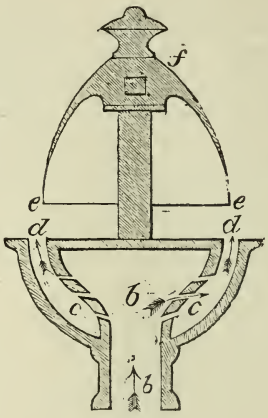


FIG. 10.

Turbines are horizontal water-wheels arranged to take advantage of the fact that water in falling takes a straight path if possible, and tends to drive any obstruction out of its way. The blades are fixed at an angle instead of being parallel with the axis, and the wheel is enclosed in a case that the whole of the water used shall be obliged to pass through the apparatus.

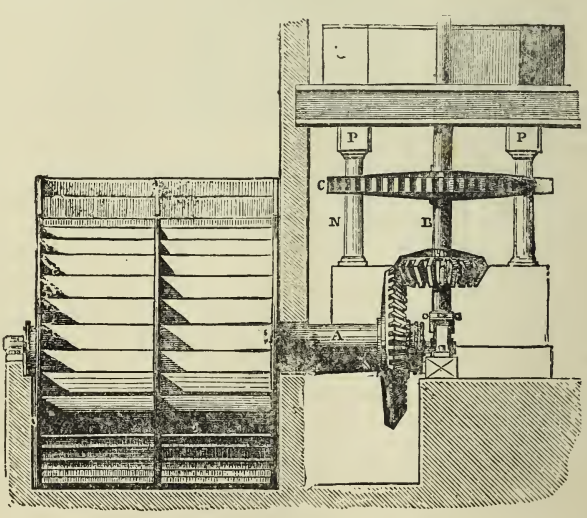


FIG. 11.

Water-wheels and turbines convert into available power either the dead weight of the water, or the impetus with which it rushes along a gradually sloping bed; they are, therefore, best adapted for use in streams and rivers, where the supply is continuous and copious. We have now to consider certain machines that are contrived to utilize the *pressure* of water; the pressure being obtained either in an artificial way, that will be described in the chapter on pressing machinery, or by a head of water, that is, a supply from a considerable elevation. In order to secure this supply, it is often necessary to erect a reservoir, supported by a tower, and to force the water up into it. The apparatus used for raising the water is generally very simple, and always similar in principle to the common *lifting pump*, shown in fig. 13. This consists of a cylinder marked *a*, in which the piston *c* is worked up and down by means of the handle. If the pump were full of water and the piston being raised, the valve *d* would be closed by the weight of water above it which would flow out at the spout, while the valve *e* would be opened by the suction and allow the water from below to pass into the cylinder. On the descent of the piston the valve *e* at once closes, *d* opening so that the piston merely passes through the water in the cylinder. Its action thus is intermittent. By closing in the top of the pump so as not to interfere with the action of the handle, and then connecting a pipe to the spout, the water would be forced to any height necessary, and the apparatus would be a *force-pump;* but it is found advantageous to modify the machine somewhat further to make it capable of resisting the great pressures to which it may be subjected when used as a force-pump. The chief change is in the substitution of a solid *plunger* for the valved piston, the valves being stationary, one on each side of the plunger: but the principle remains the same; the water is alternately drawn up into a chamber and forced out of it. The water from its elevated reservoir passes by means of a pipe to the *water pressure engine* that it is required to drive, the pressure obtained being proportional to the height of the reservoir. It will seem strange to those who are not acquainted with such matters to be told that neither the capacity of the reservoir nor the diameter of the pipe has the least influence on the pressure obtained, but a little

consideration will show that such indeed must be the case. If a large pipe and a small one were joined together at their lower ends so as to form a letter **V**, care being taken to keep the water way open from one to the other, and then water were poured in at either end, it is well known that the fluid would stand at the same level in both limbs of the compound tube. In this experiment the two columns of water must exactly balance each other, that is, they must both press downwards with the same force, or the one exercising the least pressure would be driven upward by the other. It follows, therefore, that they both press equally upon the lower point of the **V** in spite of the great difference in their absolute weights. It perhaps appears that by taking advantage of this principle it would be possible to create force; as, for instance, by dividing a water supply pipe longitudinally, for each section must exert the same pressure as the water in the original pipe. But the gain of power by such means is altogether illusory, for although the water in one half of the pipe exerts the same pressure as that exerted by the water in the undivided pipe, the pressure will be exhausted with twice the rapidity when utilized as a motive power. So that although the *pressure* in water-power engines and similar apparatus depends entirely upon the height of the reservoir, its capacity and the size of the pipe leading from it are matters of vital importance, as it is to these we must look to *maintain* that pressure during the working of the engine. The power of water, as employed in the contrivances above described, depends practically upon its gravity or weight, and hence it is not nearly so useful a motive power as is steam. There are some hydraulic sources of energy which are practically incapable of being used mechanically. Of these the tides are, by a long way, the most important.

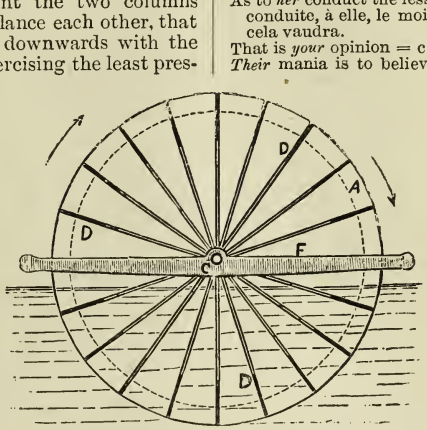


FIG. 12.—UNDERSHOT WATER-WHEEL.

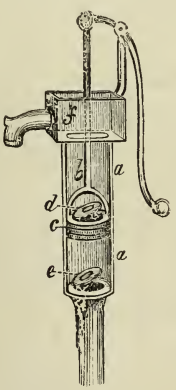


FIG. 13.

XLI.

THE VERB (*continued*).—THEORY.

3. EMPHASIS IN CONNECTION WITH THE FRENCH POSSESSIVE PRONOUN.

a. To render the antithesis contained in a text, or the emphasis which, in English, is marked by stress of voice, italicising in print, and underlining in writing, the possessive adjective pronoun is placed before the noun possessed, and preposition *à* with the personal pronoun of the possessor is placed after:

My house brings me in so much, his house brings him in twice as much = ma maison, à moi, me rapporte tant; sa maison, à lui, lui rapporte deux fois autant.

As to *her* conduct the less said the better = quant à sa conduite, à elle, le moins qu'on en parlera le mieux cela vaudra.

That is *your* opinion = c'est votre opinion à vous.

Their mania is to believe that everybody is plotting against them = leur manie, à eux, c'est de croire que tout le monde conspire contre eux.

The intensive *own* is usually translated by *propre* placed immediately after the possessive, whether pronoun or adjective:

Pour procurer du repos aux autres, il a sacrifié le sien propre, *in order to procure rest for others, he has sacrificed his own.*

Je pense à votre réputation autant qu'à la mienne propre, *I am thinking of your fair name as much as of my own.*

Mais enfin je veux songer pour la première fois de ma vie à mes propres intérêts (Mme de Sévigné), *well but, I wish to think for the first time in my life of my own interests.*

Une reine fugitive à qui sa propre patrie n'est plus qu'un triste lieu d'exil (Bossuet), *a fugitive queen to whom her own* (in this case, *native*, not the country where she had ruled) *country is no more than a sad place of exile.*

Je prétends vous traiter comme mon propre fils (Racine), *I intend to treat you as my own son* (or *a son of my own*).

Remarks.—1. More rarely *propre* is put after the noun: *les rois de France avaient alors pour revenus leurs biens propres et non ceux des peuples* (Voltaire). 2. *Propre* is rendered by *very* in the following phrase: *Avant ce jour fini, ces mains, ces propres mains, laveront dans mon sang la honte des Romains* (Corneille), before the day be ended, these hands, these *very* hands, will wash the shame of the Romans in my (own) blood.

b. A pleonasm occurs in the phrase *mon cher monsieur*, my dear sir. Ladies, in speaking to each other, also say *ma chère madame*; children writing, may be, to their (unmarried) schoolmistress, likewise say *ma chère mademoiselle*. But otherwise it is the pretty general custom to say *ma chère dame, ma chère demoiselle*; as a matter of etiquette, it is always in better taste to avoid the endearing portion of the apostrophe. Monsieur is abbreviated into M., and Messieurs into MM.; Madame into Mme, without the *d* and the period, NOT Mdme.—plural Mmes; Mademoiselle into Mlle, without the *d* and the period, NOT Mdlle. To call a man *Mons* is an insult: "*Le fils de Sommery n'avait pas honte de dire devant des gens qui avaient au moins le sens commun: le pauvre mons Turenne me disait. . . .*" (Saint-Simon), "Sommery's son was not ashamed to say before people who at the very least were possessed of common sense: this poor *mons* Turenne was saying to me . . . ." On the other hand, *le sieur* is used in judicial language: *Je plaide pour le sieur un tel, pour les sieurs tels*, I am pleading for Mr. so-and-

so, for Messrs. so-and-so. A superior, in the administrative order, might write of a subaltern: *Vous direz au sieur un tel de . . .* Also, without contempt or unnecessary respect: Un sieur Duval qui vendait des chaînes de sûreté sur le Pont-Neuf. [The question of abbreviations will be referred to again; in the meantime all those who are connected with book-writing and printing may take it that the French rule is: a period after an initial, no period after a final; M. but MME, as above; S. but SR, for *saint*, etc. For a plural MM., as above; SS. for *saints*, etc.]

c. It has already been mentioned (p. 403) that if the first noun of a series obtain the possessive adjective, the other nouns have it also: *Ne dites pas que* vos *malheurs et* vos *torts viennent de la fortune*, do not say that your misfortunes and errors are the work of fate. But there are words so intimately connected in meaning that hearing the one, you expect to hear the other: as, One must obey one's father . . . and mother; Be kind to your brothers . . . and sisters, etc. Then the plural of the possessive might be put once before the first term: *obéissez à* vos *père et mère; soyez aimable envers* vos *frères et sœurs; je fais savoir à* mes *amis et connaissances*, I bring to the notice of my friends and acquaintances; *à vos risques et périls*, at your risk.

Practical Application.

(1) VOCABULARY XX.

Poissons et Crustacés comestibles (*Edible Fishes and Shell-fishes*).

ablette,* *bleak*
anchois, *anchovy*
alose, *shad*
anguille, *eel*
barbeau, *barbel*
blanchaille, *whitebait*
brême, *bream*
brochet, *pike*
buccin, *whelk*
cabillaud, *fresh cod*
carpe, *carp*
carrelet, *flounder*
chabot, *chub*
crabe, *crab*
crevette,† *shrimp, prawn*
écrevisse, *crayfish*
éperlan, *smelt*
escargot,‡ *Roman snail*
esturgeon, *sturgeon*
fretin, *small fry*
gardon, *roach*
goujon, *gudgeon*
le hareng, *herring*
——— saur, *red herring*
le homard, *lobster*
l'huître, *oyster*
lamproie, *lamprey*
langouste, *rock lobster*
loche, *loach*
maquereau, *mackerel*
morue, *cod*
merlan, *whiting*
merluche, *haddock, dried cod*
moule, *mussel*
mulet, *grey mullet*
ombre-chevalier, *char*
peigne, *clam*
perche, *perch*
poisson de mer, *sea-fish*
——d'eau douce, *freshwater fish*
——salé, fumé, *salt, smoked fish*
——mariné, *pickled fish*
raie, *skate*
rouget, *red mullet*
sardine, *sardine*
saumon, *salmon*
sole, *sole*
stockfisch, *sun-dried fish*
tanche, *tench*
thon, *tunny*
tortue,§ *turtle*
truite, *trout*
——— saumonnée, *salmon-trout*
turbot, *turbot*
vignot, *periwinkle*

II. MODEL FOR THE CONJUGATION OF A PASSIVE VERB.

INFINITIVE.

Present—être aimé, *to be loved.*
Past—avoir été aimé, *to have been loved.*

PARTICIPLE.

Present—étant aimé, *being loved.*
Past—ayant été aimé, *having been loved.*

INDICATIVE.

Present.		*Perfect Indefinite.*	
je suis aimé	*I am loved, etc.*	j'ai été aimé	*I have been loved.*
tu es aimé		tu as été aimé	
il est aimé		il a été aimé	
elle est aimée		elle a été aimée	
nous sommes aimés		nous avons été aimés	
vous êtes aimés		vous avez été aimés	
ils sont aimés		ils ont été aimés	
elles sont aimées		elles ont été aimées	
Imperfect.		*Pluperfect.*	
j'étais aimé	*I was being loved.*	j'avais été aimé	*I had been loved.*
tu étais aimé		tu avais été aimé	
il était aimé		il avait été aimé	
nous étions aimés		nous avions été aimés	
vous étiez aimés		vous aviez été aimés	
ils étaient aimés		ils avaient été aimés	
Perfect Definite.		*Perfect Anterior.*	
je fus aimé	*I was loved.*	j'eus été aimé	*I had been loved.*
tu fus aimé		tu eus été aimé	
il fut aimé		il eut été aimé	
nous fûmes aimés		nous eûmes été aimés	
vous fûtes aimés		vous eûtes été aimés	
ils furent aimés		ils eurent été aimés	
Future Absolute.		*Future Anterior.*	
je serai aimé	*I shall be loved.*	j'aurai été aimé	*I shall have been loved.*
tu seras aimé		tu auras été aimé	
il sera aimé		il aura été aimé	
nous serons aimés		nous aurons été aimés	
vous serez aimés		vous aurez été aimés	
ils seront aimés		ils auront été aimés	

CONDITIONAL.

Present or Future.		*Past.*	
je serais aimé	*I should be loved.*	j'aurais été aimé	*I should have been loved.*
tu serais aimé		tu aurais été aimé	
il serait aimé		il aurait été aimé	
nous serions aimés		nous aurions été aimés	
vous seriez aimés		vous auriez été aimés	
ils seraient aimés		ils auraient été aimés	

IMPERATIVE.

sois aimé, *be (thou) loved.*
qu'il soit aimé, *let him be loved.*
soyons aimés, *let us be loved.*
soyez aimés, *be (ye) loved.*
qu'ils soient aimés, *let them be loved.*

SUBJUNCTIVE.

Present.		*Perfect Definite.*	
que je sois aimé	*that I may be loved.*	que j'aie été aimé	*that I may have been loved.*
que tu sois aimé		que tu aies été aimés	
qu'il soit aimé		qu'il ait été aimé	
que nous soyons aimés		que nous ayons été aimés	
que vous soyez aimés		que vous ayez été aimés	
qu'ils soient aimés		qu'ils aient été aimés	
Imperfect.		*Pluperfect.*	
que je fusse aimé	*that I might be loved.*	que j'eusse été aimé	*that I might have been loved.*
que tu fusses aimé		tu eusses été aimé	
qu'il fût aimé		il eût été aimé	
que nous fussions aimés		nous eussions été aimés	
que vous fussiez aimés		vous eussiez été aimés	
qu'ils fussent aimés		ils eussent été aimés	

EXERCISE L.

1. Les lamproies étaient préférées par les gourmands de Rome à tout autre (*any other*) poisson. On les élevait (*they* were reared*) dans de grands viviers (*ponds*) qui n'étaient destinés qu'à elles seules (*intended for . . . alone*). Tel (*such*) était le vivier construit par (*constructed by*) C. Hirtius sur le bord de la mer (*on the seashore*), et dont (*of which*) la plupart des lamproies furent dévorées aux festins offerts (*devoured at the feasts offered*) aux Romains lors (*on the occasion*) des triomphes de Jules-César. 2. Les domestiques écossais stipulaient alors (*at that time Scotch servants used to stipulate*) que le saumon ne serait servi qu'une fois par (*served only once a*) semaine à l'office (*servants' hall*). 3. Les turbotins

* See *Remark* 3 at page 306.

* With the exception of *crabe* and *peigne*, all nouns of this list, ending in *e* mute, are feminine; the others are masculine.

† Has many local names: *shrimp* = chevrette, sauterelle, salicoque, the sc. name being crangon vulgaire; *prawn* = bouquet, sc. name palémon porte-scie.

‡ *Helix pomatia*; the common garden snail is called *limaçon* or *colimaçon*; *limace* = slug.

§ A reptile, which has crept into the *menu!*

(*young t.*) sont plus prisés (*valued*) que les gros turbots, parce qu'ils (*because*) sont plus délicats. 4. Ces turbots ont été accommodés (*done*) à la sauce blanche (*with a white*), ou à l'huile (*oil*). 5. Les carpes élevées (*reared*) dans les étangs (*ponds*) sont les moins recherchées (*sought after*); elles y contractent le goût de la vase (*mud flavour*). 6. Un carpeau (*young c.*) qui n'était encore que (ne . . . que, *nothing better*) fretin, fut pris (*caught*) par un pêcheur au bord (*fisher, bank*) d'une rivière (La Fontaine). 7. Presque tous (*almost all*) les poissons, mais surtout (*especially*) les soles, les merlans, les carrelets, les limandes, les éperlans, les carpes, les tanches, les barbeaux, les goujons et tout le petit poisson blanc, peuvent (*may*) être "mis en friture" (*fried*). 8. Cette matelote de brochet serait appréciée (*appreciated*) à la table d'un roi.—Qu'est-ce qu'une (*what is a*) matelote? Ce mets (*dish*) est composé de poisson apprêté (*dressed*) au (*with*) vin et aux oignons (*onions*). 9. Les langoustes sont très estimées comme (*esteemed as an*) aliment, surtout le long des côtes (*particularly along the coasts*) de la Méditerranée. Les œufs (*eggs*) sont aussi (*also*) fort recherchés, et les femelles qui en sont pourvues (*females provided with*) se vendent (*are sold**) quatre fois plus cher (*times dearer*) que celles (*those*) qui n'en ont pas. 10. Les poissons qui ont été séchés au soleil (*dried in the sun*) sont connus (*known*) dans le commerce sous le nom (*trade under the name*) de stockfisch.

EXERCISE LI.

1. In Hamburgh, (the) lampreys are salted; *à Hambourg*
in Danzig, they are smoked. In these various *Dantzig* *sous ces divers*
states they are forwarded to the most distant *états* *expédié dans* (p. 765, v. I.)
countries, where they are served on the best [1]*contrées*, f. *servi sur* (p. 765, v. I.)
tables. 'It is an old custom for' 'the city ——, f. [2]*est dans l'usage* [1]*ville*, f.
of Gloucester' 'to present' 'a lamprey pie' ——— [3]*de faire présent* [6]*d'un pâté de . . .*
annually 'to the sovereign.' Worcester, too, [4]*chaque année* [5]*souverain* ——— *aussi*
is famous for its lamprey pies and (its) *célèbre pour*
potted lampreys. 2. The oysters fished at *conserves de . . .* *pêché en*
sea will be fattened on artificial-beds. (The) *mer* *engraissé dans les parcs*
Green oysters were then very-much inquired-for. [2]*vert* [1] (imperf.) *alors fort recherché*
3. Are your mussels all sold? 4. Mussel-sauce is *toutes* *la sauce aux . . .*
more valued by some epicures than oyster-sauce. *par quelques gourmets* *la sauce aux . . .*
5. Mussels ought not to be eaten raw. 6. These *doivent* *crues*
two people were (have been) thrown into the *personnes*, f. *jeté dans*
same mould. 7. A skate 'with-melted-butter- *même* voc. IX. *au beurre noir*
done-brown' must be dished as hot as *doit* *servi* (p. 765, v. I.) *chaud*
possible. 8. How have those soles been done? ——— *comment* *accommodé*
—they are done-brown. And your smelts?— *au gratin*
they are fried. And the eels?—they are done- *frit*
with-crumbs-and-broiled, and will be served *pané* *servi*
with a sauce 'made-up-of-yolk-of-an-egg-oil- *avec* ——— f. *à la tartare*
vinegar-pepper-salt-sweet-herbs-and-mustard.'
9. With the exception of the salmon and (of *à* ———
the) trout, fresh-water fish is (fishes are) not much thought-of in Scotland. Lampreys (p.) *estimé en* (voc. X.)
and eels are abhorred there. 10. The snails, *abhorré* (*d*, p. 199)
picked-off the vine leaves, have been sprinkled- *recueilli sur* *feuilles de vigne* *saupoudré*
with-salt, taken-out of their caps, washed *enlevé* *coquilles* *lavé*
freely-in-water, then they have been replaced *à grande eau* *puis* *remis*
with butter and sweet herbs into the caps, and *avec du beurre* *de fines herbes* *dans*
finally roasted in-the oven. 11. Will this tunny *enfin* *rôti* *au* *four*
be pickled or dried in the sun? It will be *mariné*
cured and smoked. 12. How do you wish the *salé* *comment voulez-vous qu'on*
herrings done?—I should-wish them with-a- *accommode les . . .* *voudrais*
sauce-of-butter-parsley-chives-whole-pepper- *à la maître d'hôtel*
and-lemon-juice; or perhaps broiled, with-a- *peut-être* *grillé* *à la sauce*
white caper-sauce; fried; done brown, or with- *blanche* *aux câpres* *frit* *au* *gratin*
melted-butter-done-brown. 13. To-be packed- *au* *beurre* *noir* *serré*
as-close as herrings in a barrel. 14. (The) fresh *comme des* *caque*, f.
sea-fish, which is not salted, is known in *qui* *connu en*
French under the name of *marée*. 15. At Paris, (voc. X.) *sous le nom* *à* ———
the fresh sea-fish, after having been examined *après* (governs infinitive) *visité*
by the inspector of the market, is put-up-for- *commissaire des Halles* *mis en*
sale at four (o'clock) or five o'clock A.M., *vente à* (p. 99) *du matin*
according-to the seasons. *selon* (voc. XIII.)

* See *Remark* 3 at page 306.

EXERCISE LII.

1. My master *requests your acceptance of* (p. 590, vol. I.)
(begs you to accept) this basket of oysters. *prier* *d'* *cloyère*, f. *d'*
2. What are you waiting for? I am waiting *qu'*
for the fish train. 3. We were looking for *le convoi de marée*
small trouts under the stones. 4. What more *que* [2]*de plus*
would you wish for? I could wish for (a) [1]*pourriez-vous* *pourrais* *un*
crayfish-soup or (a) Provençal-fish-soup. 5. *potage à la bisque* *une bouillabaisse*
Do-you wish-me-to look for the fish-slice? *voulez-vous que je* *la truelle à poisson*
Yes, do (look for it). 6. Will you permit my *la*
youngest son to fish in your ponds? Certainly, (*f*, p. 6) *de pêcher* *de bon cœur*,
if it is for angling. 7. My factor will *si c'* *pour la pêche à la ligne* *intendant*
answer all applications for fishing. 8. It *toutes les demandes d'autorisation* *de pêche*

is strictly forbidden to fish with-the-sweep-net.
expressement de à l'épervier
9. When we go fishing we always obey the
quand allons à la pêche [2] *toujours* [1]
regulations. 10. Papa, where is my fishing-
règlements mes articles de
tackle? Look for it, my boy. 11. If you order
(them)
the boatman to stop near the pool, we shall
batelier de s'arrêter près du trou nous ne
not return with empty baskets. 12. The
nous en retournerons pas à vide (or *bredouille*)
pike does not resist that bait. Would the
appât, m.
salmon resist it? Of course. 13. Does not
(p. 199) *naturellement*
char resemble trout a little? It resembles it,
l [2] *la* — [1] *un peu* (p. 199)
only char has more-vivid colours and
seulement [2] *vif* [1] *des couleurs*, f.
possesses a more-delicate flavour. 14. Those
possède [2] *fin* [1] *goût*, m.
rock lobsters will not suit my mistress.
conviendront (p. 590, v. I.)
Will they suit her if I make them two francs
fais
cheaper? 15. How these minnows seem *to*
meilleur marché comme vairons semblent
enjoy life! 16. How the young-carps enjoy
carpillons
their liberty since they were (have been)
liberté depuis qu'ils
put from the castle-moat into the river. 17.
transféré des fossés du château dans la rivière
It-is-reported that the Fontainebleau carps
on raconte
(c. of F.) date from the reign of Francis I.
datent règne, m. *François I.*
Tell-it-the-marines. If you doubt the fact,
à d'autres! *fait*, m.
inquire about it. 18. Do not cover the jar;
informez-vous-en ne couvrez donc par le bocal
if your gold-fish* lack air, they lack every-
poissons rouges *tout*
thing.

XXII.

Voltaic Electricity.

One of the most important facts bearing upon the connection between electricity and magnetism is that an electric current has a certain and definite action upon a freely suspended magnetic needle.

Deflection of magnets by currents.

This fact, which forms the starting-point in the development of the electric telegraph and many other equally useful though perhaps less generally known appliances, was first discovered in 1819. We have already alluded to this so-called *directive influence* possessed by currents over magnets, for the sake of perfect clearness, but we will remind our readers that if a copper wire be arranged so as to lie exactly in the magnetic meridian, and if a freely suspended magnet be brought near the wire, it will be deflected when a current passes through the wire, the direction of its deflection being dependent upon the direction of the current, and upon the position of the needle whether above or below the wire.

* Scientific name: *cyprin doré*, or *dorade de la Chine*.

The best way to perform the experiment is to construct a small wooden frame, as represented in fig. 76, and stretch across it a piece of stoutish copper wire. To each end of this wire attach a piece of thin copper wire,

A piece of simple apparatus.

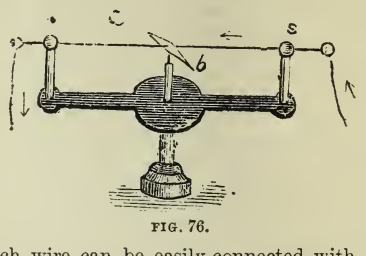


FIG. 76.

which wire can be easily connected with the battery by binding screws; it will moreover be easy to reverse the direction of the current by simply changing the connection of the wires with the poles of the battery. The magnetic meridian can easily be obtained by letting the magnetic needle come to rest. It will be found best to suspend the needle by unspun (cocoon) silk. Having found the magnetic meridian, place the wire exactly in it, which it of course will be when its direction coincides with that of the needle, and first let the wire be *above* the needle. Now join the terminal wires to the poles of the battery, so that the current passes, as in the figure, from south to north. The needle will be deflected, so that its north pole turns to the *west*. Now reverse the current by reversing the wires, and let it pass from north to south. The needle will be deflected, but its north pole will turn towards the *east*. If the needle be next suspended so that the wire is *beneath* it, and the same experiments repeated, it will be found that when the current passes from north to south the north pole of the needle turns to the *west*; while if the current be allowed to pass in the opposite direction, the needle will be deflected with its north pole to the *east*.

By this it will be at once seen that we have in this directive action of currents upon magnets a ready means of detecting not only the existence, but the direction of an electric current. Moreover, as may be proved by experiment, the deflection of the needle being greater as the strength of the current increases, we have also a ready means of measuring *current strength*.

Measurement of current strength.

It is somewhat puzzling at first to accurately remember the way in which the north pole of the needle is deflected in obedience to the direction of the current and the position of the needle. To obviate this difficulty, the following *memoria technica*, due to Ampère, may be found useful by our readers. Conceive a man to be lying on the connecting wire, so that, whatever the direction of the current, it always enters at his feet and leaves by his

head ; conceive, moreover, his face always to be turned towards the needle, *the north pole of the needle will always be deflected towards this hypothetical man's left hand.*

The galvanometer. A further examination of this directive action of electrical currents speedily led to the discovery of the fact, that by making a number of coils of wire round the needle, the action of the current was greatly intensified, so that by having a number of coils of wire, a very small current might be made to influence the needle ; and this soon resulted in the invention of the so-called *galvanometer*, by which the direction and comparative amounts of small electrical currents may be measured.

In order to make the principle upon which the action of this instrument depends perfectly plain to our readers, it will be necessary to enter upon a few preliminary considerations, before proceeding to a description of the manner in which the instrument is constructed and employed.

Preliminary explanation.

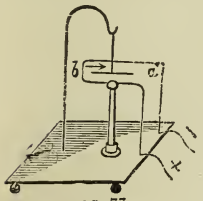


FIG. 77.

Suppose we have, as represented in fig. 77, a magnetic needle suspended by a thread of unspun silk in the magnetic meridian. If we have a copper wire wound longitudinally once round the needle in the same vertical plane, and if we have a current passing through it in the direction indicated by the arrow in the diagram, it will be found, by making use of the *memoria technica* given above, that the left hand of the man will always point towards the same point of the horizon ; that is to say, the north pole of the needle will be induced to turn in the same direction by all parts of the current. The effect of the current therefore has been *multiplied* by the doubling of the wire. In the same way if several coils of wire, coiled in the same direction, and *insulated from each other*, be wound round the needle, the effect of the current will be increased still further.

In employing, however, a *single* needle we have the directive action of the earth upon it to take into account, and therefore must, to get any effect, employ a current that is strong enough to overcome this directive action. This inconvenience is to some extent obviated by employing *two* magnetic needles in the form of an *astatic combination*, as represented in fig. 78.

The astatic combination.

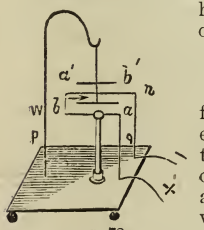


FIG. 78.

Here *a b*, *a' b'* are two magnetic needles parallel to each other and connected, as shown, by copper wire. The needles are so arranged that the north pole of one is opposite the south pole of the other, and *vice versâ*. By this device the directive action of the earth is to a very great extent neutralized ; if the needles were absolutely of the same strength it would be *quite* neutralized, but it is hardly possible to perfectly secure this. But in addition to this neutralization of the earth's directive action, the influence of the current is increased by the employment of two needles in the place of one.

The needles are arranged as shown in the diagram, the upper one being altogether above the wire, the lower one being between the two folds of the wire. Supposing the current to pass in the direction shown by the arrow, the upper needle will be influenced by two currents flowing in opposite directions ; of these, however, the upper and nearer one will have the greatest effect, and will therefore tend to turn *b'a'* so that *a'* is deflected towards the east. The current flowing both above and below the other needle, will tend to turn it in the same direction. In this way the current tends to turn both needles in the same direction, this tendency being only slightly counteracted by the current in the lower part of the wire acting on the upper needle, but this action being at a great distance, is correspondingly enfeebled.

Having, we hope, now made clear to our readers the principle upon which the action of the galvanometer depends, we hope they will be encouraged to make one, which will be found with ordinary care and skill by no means a formidable task.

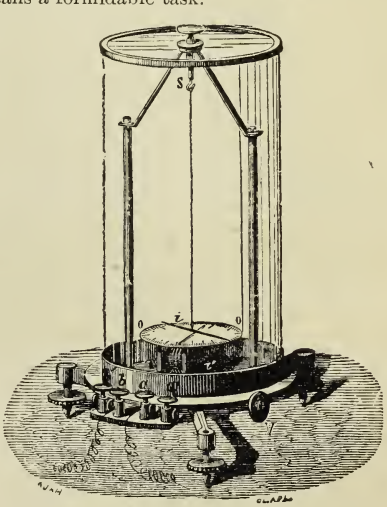


FIG. 79.—THE ASTATIC GALVANOMETER.

How to make an astatic galvanometer. In fig. 79 will be seen a view of the perfect instrument as ordinarily made for the lecture table; one or two modifications may, however, be made in its construction by the amateur electrician.

The first thing will be to get about a hundred feet of fine copper wire *covered with cotton ;* No. 20 will be found a good size. This you must divide into halves, and of each half you must make a complete coil, leaving the two ends free. The best way to coil the wire

is to get a small wooden block and carefully wind the wire upon it, removing the block after securing the coil by tying it with thread. Those who have the time and skill may make a permanent wooden frame, as shown in the diagram, upon which to coil the wire, which will greatly add to the neatness and finish of the instrument. Having made the two coils, fix them on the frame side by side, leaving a space of say a quarter of an inch between them, and carefully solder two of the free ends of the coils together so as to convert them into one continuous coil. The next thing will be to get a wooden stand, which should consist of a disc of wood about three quarters of an inch in thickness. This may easily be cut from any ordinary piece of deal and the corners rounded off with a rasp. If then coated with shellac varnish, it will constitute a neat and useful stand. Make two small holes under the coil, and bring the two ends of the coil through these holes to the under surface of the stand. In what is to be the front part of the stand fix two binding-screws, so that their lower ends project slightly on the under surface of the stand. Join one wire of the coil to one binding-screw and the other wire to the other screw. To suspend the needle it will be best to get a stout piece of brass wire and bend it into the form of a flat-topped arch, as shown in the margin, fixing the ends firmly into the stand by the side of the coils. The next step will be to make an astatic needle. Magnetise two small pieces of steel wire (sewing needles will do well, pieces of knitting needle better), and join them by a piece of twisted copper wire, so that their opposite poles face each other. On the same axis above the upper needle fix a slender glass thread, about four inches long, to answer the purpose of an index. Suspend this combination by a thread of unspun silk. The glass index may be made by taking a piece of fine soft glass tubing, heating it in an ordinary gas burner, and drawing it out to the required fineness. It will be found best to attach the upper end of the silk to a small cork roller, which can easily be fitted on to the top of the wire arch before fixing the latter to the stand. The next, and perhaps most difficult task, is to get a piece of cardboard and cut it into a circle, and then graduate half the circumference of the circle into 180 degrees—that is, 90 degrees on each side of the zero point. A little patience and a good protractor will soon, however, enable the amateur electrician to finish this part of his task to his satisfaction. Having done so, it only remains for him to put the card and astatic combination in their respective positions as shown in our diagram, and to cover the whole with an ordinary glass shade such as is used to cover ornaments, and which may be purchased for a few pence. If a frame has been made, the card may be allowed to rest upon it, but if (as must be done when the frame is dispensed with) the coils have been fastened directly to the stand, the card must be supported by two pieces of wood or cork glued on to the stand. The card should not be fixed to these or to the wooden frame.

In using this instrument allow the needle to come to rest, and then move the graduated card so that the end of the glass index points to the zero of the scale. Then connect the two ends of the cell or other circuit to be tested with the binding-screws of the galvanometer. The direction of the deflection of the needle will indicate the direction of the current, and the amount of the deflection will vary with the intensity of the current. The galvanometer is, however, not well adapted to give exact quantitative measurements of the strength of currents, and is used only for the detection of currents, for determining their direction, and for roughly comparing their intensities. For instance, if two currents be compared with regard to their intensities, and one gives a deflection of 50° and the other one of 25°, it would not necessarily follow that the first current was of *double* the intensity of the second, but all that could be safely asserted would be that the first was of greater intensity than the second, without giving any quantitative estimate of the amount of their difference. Moreover, the graduation of every galvanometer has a special value of its own, a current producing a certain deflection with one galvanometer producing a different deflection with another instrument. It will also be found best to employ at the commencement of an experiment a current of *known* direction, when the direction of the deflection by this current can be noticed, and this will, of course, serve as a guide for determining the direction of other currents which it may be required to test.

How to use the astatic galvanometer.

XLVIII.

Rule of Louis XIV. (*continued*).

It was in 1672 that Louis, at the head of a force of a hundred thousand men, with both Condé and Turenne in command, crossed the Rhine and poured a flood of invasion into Holland, like that brought by Xerxes in old times into Greece. The Hollanders were astonished and paralysed by the sudden and overwhelming onslaught. The spectacle of the campaigns of Flanders and Franche Comté was again enacted with still greater brilliancy and rapidity of success. Town after town surrendered to the magnificent force led by the French king and his renowned generals. The provinces of Utrecht, Gueldres, and Overyssel were quickly conquered; and the victorious army was within a few leagues of Amsterdam itself. Overtures of peace made by John de Witt, the Grand Pensionary, were contemptuously rejected; and that unhappy ruler and his brother

Invasion of Holland by Louis XIV., 1672.

Cornelius were murdered by a mob roused to frenzy by fear, in the streets of the Hague. On the other hand, the young Prince of Orange, being made stadtholder in this emergency, resolved to resist to the very end, "to die in the last ditch," or rather than yield to found a new republic in the islands of the Eastern Seas.

By the desperate expedient of cutting the dykes and inundating whole districts, Amsterdam was saved. Brave Admiral de Ruyter manfully upheld the honour of Holland at sea, fighting a brave battle against the French and English fleets, at the mouth of the Texel, and stoutly held his own in other combats. The spectacle of Holland fighting desperately for her very existence roused the indignation of various nations of Europe against her oppressor, against whose dangerous ambition the greater part of Europe was in turn arrayed. In 1674 the parliament compelled Charles II. to conclude a separate peace with Holland; Spain and the Empire took up arms in defence of the independence of Holland; and Frederick William of Brandenburg, known as the Great Elector, also declared for William.

Valiant defence of Holland.

Frederick William the great Elector.

Thus had Louis lit the torch of war that produced a general conflagration in Europe. While Condé was fighting in Flanders, Turenne received orders from the war minister, Louvois, to lay waste the Palatinate of the Rhine, to produce a belt of desolation on the frontier. This ferocious command was but too well obeyed: the smiling country, with its vines, cornfields, and orchards, was turned into a wilderness; towns and villages were laid in ashes, and of their expelled inhabitants many thousands perished miserably. On the Moselle and the Saar the same barbarous system was pursued, and the remembrance of the outrages then committed still lives as a tradition among the German peasantry.

The Palatinate devastated.

But in this case Louvois overshot his mark. The indignation excited by these cruel proceedings at last called all Europe to the aid of Holland. Besides the Empire and Spain, Brandenburg, Osnaburg, and Münster were arrayed against Louis. Montecuculi, a foeman not unworthy of the steel even of Turenne, was now opposed to that great leader; and Louis found it expedient to evacuate Holland.

Thus 1674 found Condé combating in the Netherlands, Turenne on the Rhine, and Louis himself in Franche Comté. The Prince of Orange encountered Condé at Senef; each side claimed the victory, but even a drawn battle against Condé was a triumph. In 1675 France suffered great loss in the death of Turenne, who died a soldier's death, in his sixty-fifth year, being killed by a cannon ball at Salzback, not far from Strasburg, when about to give battle to Montecuculi. In the next campaign Louis himself and his brother were successful; and a naval commander, Du Quesne, gained a great victory in the Mediterranean, near Messina, in April 1676, De Ruyter, the Dutch admiral, being killed in the action. But the country was feeling the exhaustion caused by the long and expensive war; and Louis adroitly agreed to the treaty of Nimeguen, in 1678, by which he retained Franche Comté and some important fortresses on the Belgian frontier, while Holland maintained her independence. Alsace also fell into the hands of the French king, who, moreover, received at this time from his flatterers the title of the Great, which he appears very little to have deserved.

Battle of Senef, 1674. Death of Turenne, 1675.

Treaty of Nimeguen, 1678.

The conclusion of peace did not put a stop to the demands and the aggression of the king of France. He revived antiquated or pretended claims to various provinces, and supported these claims by bribed courts called Chambers de Réunion at Breisach and Metz. He seized on Strasburg in a time of profound peace in 1682, bombarded Luxemburg, bought the Italian town of Casale, once more humiliated the pope by menace and insult in his capital, compelled the Doge of Genoa to come to him as a suppliant, threatened the Empire and Holland, and alarmed and astonished Europe by his arrogance and ambition. Then it was that William of Orange, the indomitable stadtholder, brought about the league of Augsburg, in which the emperor of Germany, the kings of Spain and of Sweden, and the electors of Saxony, Bavaria, and Brandenburg, with the majority of the Protestant princes of Germany, took part, to check the aggressive spirit of the French king. And even the pope seconded this movement, though it was initiated by a heretical prince, and directed against the "eldest son of the church."

Acquisition of Strasburg, etc.

The league of Augsburg.

Louis had long been determined to establish in France that desideratum of tyrants, compulsory uniformity in matters of religion. He had long shown an intolerant feeling even towards the best of his servants who were of the reformed faith; so that stout Duquesne, a Protestant, once said to him: "When I fought your Majesty's enemies, I did not ask what religion they were of." As he advanced in years, and the outward magnificence of fêtes and entertainments began to pall upon him, he turned towards religion; and despotic in this direction, as in every other, in 1685 he deprived his Protestant subjects, by the revocation of the edict of Nantes, of the one great guarantee they had for the freedom of their faith. This edict had been granted by Henry IV. in 1598, to put an end to the long strife between Catholic and Huguenot that had devastated France.

Religious rule. Revocation of the edict of Nantes.

Having once taken the decisive step, the king followed it up by the strongest compulsory measures against all who refused to conform. Every form of persecution was put into action against the Huguenots, who were to be literally "dragooned" into obedience; soldiers were quartered in their houses, and thousands among them were sent to expiate their dis-

Oppression of the Huguenots.

obedience to the royal mandate at the galleys among the vilest criminals. The consequence was, that numbers of the most useful and industrious of Louis' subjects fled from France, to England, Holland, and other countries where they could worship according to their consciences; and thus was France deprived of many thousands of her natural defenders, at a time when the warlike policy of the king rendered necessary the presence of every man who could fight in her cause.

Second invasion of the Palatinate.

For Louis replied to the league of Augsburg by a second invasion of the Palatinate, in which the ruthless plan of Louvois was more completely carried out than before. Heidelburg, Spires, and Worms, and a number of other cities, were laid waste with merciless cruelty. Everywhere was desolation and ruin; and the requitals that were naturally provoked by this course gave an additional asperity to the war. It was at this time, also, that the revolution occurred in England (1688) which drove James II. from the throne. Louis refused to acknowledge his old enemy William of Orange as king of England; and assisted the cause of James with men and money. Thus the war went on: and the Marshal de Luxemburg won a great battle for Louis at Fleurus, near Namur, in 1690, and a still greater triumph at Steenkirk, in Hainault, in 1692. Indeed, it has been rightly said of William III. that he belonged to that class of commanders who, though of acknowledged stoutness and valour, seldom won battles. But his indomitable perseverance gave him the triumph in the end.

UTRECHT.

In 1693 a victory was gained for Louis at Neerwinden, in the province of Liege, and Catinat in Piedmont also fought for Louis. But against these triumphs must be placed the tremendous defeat suffered by his navy, at the hands of the English and Dutch fleets, off Cape La Hogue, in 1692. By sea and land the war continued to rage; and no victories could compensate for the exhaustion that was coming upon France, in this long strife provoked by the unprincipled ambition of her ruler.

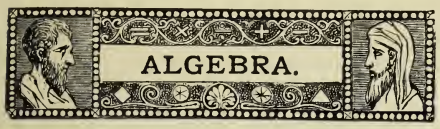
Sea fight at La Hogue.

As this exhaustion became manifest in spite of all efforts to conceal it, the hopes of the enemies rose. Luxemburg, the great general, and Louvois the great war minister, were no more; though Vauban, most scientific of engineers, remained to fortify the places that fell into his master's hands. But now a great triumph was achieved by William III. in the capture of Namur; and Louis, anxious for peace, concluded the treaty of Ryswick with his enemies in 1697, in which, contrary to his previous practice, he largely made restitution, giving back all his conquests to the crown of Spain, to the Empire, to Holland, and to England, with the exception of Roumillon, Astors, Franche Comté, and Strasburg; and also restoring his possession to the Duke of Lorraine. Louis also acknowledged William III. as King of England.

Treaty of Ryswick, 1697.

The peace of Ryswick marks the termination of the brilliant period of Louis XIV.'s reign. The reaction had already begun, which was to throw a terrible gloom over his old age. Many of the men on whom he was most accustomed to rely were dead. Colbert the honest financier, Louvois the able war minister, Condé and Turenne, Duguerre, and Luxemburg. His gigantic structures, his expensive wars, and the boundless extravagance in fêtes and pleasures of all kinds, had emptied his exchequer and impoverished the people; satiety made magnificence and adulation pall upon him, and the influence of Madame de Maintenon, to whom he was privately married after the death of his consort Maria Theresa, developed in him a gloomy superstition which he called religion. "The king, disenchanted on every subject, and prematurely aged, felt weary amid the fêtes of his court, which had no longer the brilliancy of former times, engendered by pride and youth and hope for the future." In an absolute monarchy, the whole nation lives the life of the monarch. France was growing weak and gloomy with Louis XIV.

We come now to speak of a topic which at the close of the seventeenth century attracted great attention throughout Europe, forming, indeed, one of the most prominent difficulties of the day: we allude to the succession to the throne of the Spanish kingdom, a kingdom now on the verge of ruin.



V.

Fractions (*continued*).

If we divide the numerator and denominator of a fraction by the greatest common measure of its numerator and denominator, we reduce it to its "lowest terms"—*i.e.*, we make its terms (numerator and denominator) as small as possible without altering the value of the fraction.

Thus, to reduce to its lowest terms $\frac{21}{49}$, divide numerator and denominator by their greatest common measure, which is 7. $\frac{21}{49}=\frac{3}{7}$.

Examples.

Reduce to their lowest terms—

(1) $\frac{6a^4c^3}{12a^3c^2}$. Ans. $\frac{1}{2}a^4c^3$.

(2) $\frac{a^2-ab-2b^2}{a^2-3ab+2b^2}$. Ans. $\frac{a+b}{a-b}$.

(3) $\frac{a^4-x^4}{a^3-a^2x-ax^2+x^3}$. Ans. $\frac{a^2+x^2}{a-x}$.

All the examples given in connection with the greatest common measure may be used for this, if they be written as fractions and reduced by dividing by their greatest common measures.

We have seen in arithmetic that when we wish to *compare the values* of fractions, or to *add* or *subtract* them, we must treat them in such a way that they shall all have the same denominator.

In Algebra, as in arithmetic, we find the

STREET SCENE IN ANTWERP.

Reduce $\frac{12bx^2y}{16ax^2y^2}$ to its lowest terms. The greatest common measure of the numerator and denominator is $4x^2y$. Dividing by this, we get $\frac{3b}{4ay}$.

Reduce $\frac{(a+b)^5\,(c+d)^2}{(a+b)^2\,(c+d)^3}$ to its lowest terms. Numerator and denominator are obviously divisible by $(a+b)^2(c+d)^2$. Removing this common factor, we have $\frac{(a+b)^3}{c+d}$.

Reduce $\frac{x^3-a^3}{x^4-a^4}$ to its lowest terms. Dividing by the G.C.M. $x-a$, we have

$$\frac{x^2+ax+a^2}{x^3+ax^2+a^2x+a^3}.$$

"common denominator" of any number o fractions by finding the "least common multiple" of the individual denominators. The least, or better, lowest, common multiple of any number of expressions is the lowest expression which contains each of them without remainder. Thus the L.C.M. of $4a^2x$ and $6ax^2$ is $12a^2x^2$.

To find the L.C.M. of two expressions, proceed as in arithmetic—namely, divide one of them by their greatest common measure, and multiply the quotient by the other expression, or multiply the two expressions together and divide by the greatest common measure.

Thus, to find the least common multiple of a^3+a^2b and a^2-b^2. The greatest common measure of these expressions is $a+b$ Dividing a^3+a^2b by $a+b$ we get a^2. Multiply a^2-b^2 by this quotient, and we get $a^2(a^2-b^2)$, or $a^4-a^2b^2$, the least common multiple required. Otherwise, multipling a^3+a^2b and a^2-b^2

together, we get $a^5 + a^4b - a^3b^2 - a^2b^3$. This divided by the greatest common measure $a + b$ gives $a^4 - a^2b^2$, the least common multiple as before.

To transform fractions which have not a common denominator to others of the same value with a common denominator, proceed as in arithmetic—namely, find the L.C.M. of the individual denominators. This will be the required common denominator. To find the new numerators which when placed over this denominator will give fractions of the same value as the original fractions, divide for each numerator the common denominator by the original denominator, and multiply the quotient by the numerator.

Thus reduce $\frac{3}{4a}$, $\frac{4b}{3c}$, and $\frac{5d}{6b}$ to others equal to them in value, having a common denominator. The L.C.M. of $4a$, $3c$, and $6b$ is $12abc$. The quotients are $3bc$, $4ab$, and $2ac$, which being multiplied by the old numerators give the new numerators $9bc$, $16ab^2$, and $10acd$; and the fractions required are $\frac{9bc}{12abc}$, $\frac{16ab^2}{12abc}$, $\frac{16acd}{12abc}$.

Examples.

Reduce to other fractions of equal value having a common denominator.

1. $\frac{a}{b}$, $\frac{c}{d}$, $\frac{e}{f}$. Ans. $\frac{adf}{bdf}$, $\frac{cbf}{bdf}$, $\frac{ebd}{bdf}$.

2. $\frac{2a}{b}$, $\frac{c}{d}$. Ans. $\frac{2ad}{bd}$, $\frac{cd}{bd}$.

3. $\frac{a+x^2}{x}$, $\frac{a^2-x}{y}$, $\frac{a}{x^m}$.
Ans. $\frac{(ax^m + x^{m+2})y}{x^{m+1}y}$, $\frac{a^2x^{m+1} - x^{m+2}}{x^{m+1}y}$ and $\frac{axy}{x^{m+1}y}$.

4. $\frac{a+2}{\frac{1}{2}a+4}$, $\frac{a+4}{\frac{1}{2}+5}$.
Ans. $\frac{\frac{1}{2}a^2+6a+10}{\frac{1}{4}a^2+\frac{9}{2}a+20}$; $\frac{\frac{1}{2}a^2+6a+16}{\frac{1}{4}a^2+\frac{9}{2}a+20}$.

5. $\frac{a^2-x^2}{a^2}$, $\frac{a+x}{b}$, $\frac{b}{a-x}$.
Ans. $\frac{a^3b-2abx^2+x^3b}{a^3b-a^2bx}$, $\frac{a^4-a^2x}{a^3b-a^2bx}$, $\frac{a^2b^2}{a^3b-a^2bx}$.

ADDITION AND SUBTRACTION OF FRACTIONS.

The rule is the same as in arithmetic. Reduce all the fractions to equal ones having a common denominator; add or subtract the new numerators, and place their sum or difference as numerator over the common denominator.

Thus, to add $\frac{a+b}{c}$ and $\frac{b-d}{e}$.

The common denominator is ce. The new numerator of the first fraction is $a+b$ multiplied by e—i.e. $(a+b)e$ or $ae+be$. Similarly the new numerator of the second fraction is $(b-d)c$ or $bc-cd$. The required sum is $\frac{ae+be}{ce} + \frac{bc-cd}{ce}$; that is $\frac{ae+be+bc-cd}{ce}$, which might also be written $\frac{(a+b)e+(b-d)c}{ce}$.

The student will notice from this that whenever we have a fraction with a numerator of several terms, we may separate the fraction into several, each having as numerator one term or more of the original numerator, and having the common denominator as denominator. Thus—

$$\frac{a^2-b^2+c^2}{abc} = \frac{a^2}{abc} - \frac{b^2}{abc} + \frac{c^2}{abc}.$$

The numerator may often be simplified—as

Add $\frac{1}{x-2} - \frac{3}{x+2} + \frac{2x}{(x+2)^2}$.

The common denominator is $(x-2)(x+2)^2$. The numerators become $(x+2)^2$, $3(x-2)(x+2)$, and $2x(x-2)$; and the sum is

$$\frac{(x+2)^2 - 3(x-2)(x+2) + 2x(x-2)}{(x-2)(x+2)^2}.$$

$(x+2)^2 = x^2 + 4x + 4$; $1(x-2)(x+2) = x^2 - 4$, and $2x(x-2) = 2x^2 - 4x$; therefore the numerator is

$$x^2 + 4x + 4 - 3(x^2 - 4) + 2x^2 - 4x = 16,$$

because we have $3x^2 - 3x^2$, which is 0, and $4x - 4x$, which is also 0. The whole fraction then is

$$\frac{16}{(x-2)(x+2)^2}.$$

It is often convenient to keep the common denominator in its factors during the process of working out, and only multiply the factors together when we have simplified the numerator. The denominator may often be simplified in the same manner as the numerator above.

Examples.

1. Add $3x + \left(x + \frac{3a}{4}\right) + \left(4x - \frac{6a}{5}\right)$.
Ans. $8x - \frac{9a}{20}$.

2. „ $4x + 3x + \frac{2x-5}{3} + 5x - \frac{x-1}{2x}$.
Ans. $12x + \frac{4x^2 - 13x + 3}{6x}$.

3. „ $\frac{a}{b} + \frac{c}{d}$. Ans. $\frac{ad+bc}{bd}$.

4. „ $\frac{1}{a+b} + \frac{1}{a-b}$. Ans. $\frac{2a}{a^2-b^2}$

5. „ $\frac{2x+3}{5} + \frac{3x-1}{2x} + \frac{4x}{7}$.
Ans. $\frac{68x^2 + 147x - 35}{70x}$.

6. „ $2 + \frac{a+b}{a-b} + \frac{a-b}{a+b}$. Ans. $\frac{4a^2}{a^2-b}$.

7. From $\frac{a}{b}$ subtract $\frac{c}{b}$. Ans. $\frac{a-c}{b}$.

8. „ $\frac{4x}{5}$ „ $\frac{3x}{5}$. Ans. $\frac{x}{5}$.

9. „ $\frac{a}{b}$ „ $\frac{c}{d}$. Ans. $\frac{ad-bc}{bd}$.

10. „ a „ $\frac{cd}{b}$. Ans. $\frac{ab-cd}{b}$.

11. From $\frac{a}{b}$ subtract $\frac{c+d}{c-d}$.

Ans. $\frac{ac-ad-bc-bd}{bc-bd}$.

12. Show that

$$\frac{3x+y}{5a+x}\,\frac{a-2y}{a-x} = -5a^2+\frac{2ax+11ay-3x^2+xy}{5a^2-4ax-x^2}.$$

13. Also that

$$\frac{c-d}{a+b}-\frac{a-2d}{a-b}=\frac{ac-a^2+3ad-bc-ab+bd}{a^2-b^2}.$$

14. Also that

$$a^2-\frac{ab}{c}\,33\left(a^2-\frac{10}{c^2}\right)=-2a^2-\frac{abc-10}{c^2}.$$

15. From $\frac{z^2+zv}{z-v}$ take $\frac{zv+v^2}{z-v}$. Ans. $z+v$.

16. „ $\frac{5a-2x}{2a-9x}$ take $\frac{a+x}{3a-2x}$.

Ans. $\frac{13a^2-9ax+13x^2}{6a^2-31ax+18x^2}$.

17. „ $x-\frac{x^2}{2a+x}$ take $a-\frac{a^2}{2x+a}$.

Ans. $\frac{2ax^2-2a^2x}{2a^2+5ax+2x^2}$.

By considering the rule of signs which we applied both in multiplication and division, we see that $\frac{a}{b}=\frac{-a}{-b}$; and that $\frac{-a}{b}=\frac{a}{-b}=\frac{-a}{b}$.

A little reflection on the part of the student will show him the truth of the following principle: *If the sign of any one factor of* EITHER *numerator or denominator be changed, the sign of the whole fraction is thereby changed.* This principle is of constant use in dealing with fractions.

For instance, find the value of

$$\frac{1}{(a-b)(a-c)}+\frac{1}{(b-c)(c-a)}.$$

The latter fraction

$$\frac{1}{(b-c)(c-a)}=\frac{1}{(b-c)\times-(a-c)}.$$

$$[\because c-a=-(a-c)]=-\frac{1}{(b-c)(a-c)}.$$

So that

$$\frac{1}{(a-b)(a-c)}+\frac{1}{(b-c)(c-a)}=\frac{1}{(a-b)(a-c)}-\frac{1}{(b-c)(a-c)},$$

and we now see that the common denominator of the two fractions is $(a-b)(a-c)(b-c)$, and the value of the whole given expression is

$$\frac{b-c-(a-b)}{(a-b)(a-c)(b-c)}, \text{ or } \frac{2b-c-a}{(a-b)(a-c)(b-c)}$$

The student must pay great attention to the fact that we do not change the sign of any quantity when we change the signs of an even number of its factors, and that we do change its sign when we change the signs of an odd number of its factors. Consequently, in fractions, when we change the signs of an *odd* number of the factors of the denominator, we must also change the sign of the numerator; but when we change the signs of an *even* number of the factors we leave the numerator unchanged.

When a fraction with a negative sign before it is to be combined with another fraction, or otherwise operated upon, it is well to enclose the numerator, if it be not a simple expression, in a bracket. If not actually so enclosed, the bracket must be imagined, because the numerator *must* be treated as one quantity.

VI.

SOUND (*continued*).

ONE of the most beautiful discoveries in the science of acoustics is that made by Chladni, by virtue of which it is possible to render apparent the vibrations of sounding plates. In our chapters upon electricity will be found a notice of certain figures, known as Lichtenberg's Figures, formed by spreading an electrified powder over the surface of an electrified cake of resin; it was the sight of these figures which led Chladni to test the possibility of rendering apparent sonorous vibrations.

Chladni's Figures.

To illustrate Chladni's discovery all that is required is a good square plate of glass, or metal with rounded edges, an ordinary fiddle bow, a small clamp, and a little fine, dry sand. Possessed of these materials the student may verify for himself the facts we are about to state and illustrate. Let the plate be fixed either upon a stand, as in fig. 23, or by a clamp to a table or similar support. If then

Vibrations of square plates.

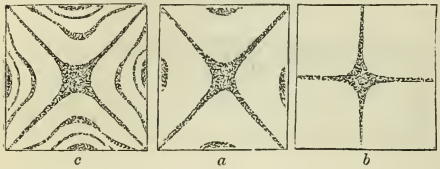
FIG. 23.

the middle point of one of its edges be damped by touching it lightly with the finger, and the bow be drawn sharply across the edge about half-way between the finger and the adjacent corner of the plate, the fundamental tone will be sounded, and at the same time the sand (previously sprinkled upon the plate) will

arrange itself in two sharply-defined lines crossing each other at the centre of the plate as in *b*, fig. 24.

These lines upon which the sand accumulates are termed *nodal lines*, and correspond to the *nodes* of a string; the clear spaces are *vibrating segments* answering to the ventral segments of a string. The diagonally opposite segments of the plate vibrate together, moving

Nodal lines and vibrating segments.



c *a* *b*

FIG. 24.

upwards and downwards like two pairs of wings; when one pair are seen to be moving downwards, the other are observed to be moving upwards, and *vice versâ*. When the plate begins to move the sand is tossed off the vibrating segments and collects on the nodal lines, which are, however, not lines of *absolute*, but only of *comparative*, rest. By damping a corner of the plate and drawing the bow across the centre of one side, the first overtone of the plate is produced, and the sound arranges itself upon the diagonals of the plate, as in *a*, fig. 24. By varying the point which is damped and that which is "bowed," a wonderful variety of patterns is produced, each pattern corresponding to a particular overtone, and becoming more complex as the pitch of the note is increased. It will be seen that in producing a particular pattern the finger must always be placed where a nodal line is desired, and the bow must be drawn across the centre of a vibrating segment: see *b*, *c*, fig. 24.

If a circular plate be substituted for a square one, figures are obtained which always consist of radii of circles springing from the clamped spot in the centre. The number of radii when the fundamental note is sounded is 4, and the successive overtones are marked by 6, 8, 10, 12, etc., radii, the number being always an even one. The rate of vibration of a disc is directly proportional to its thickness, and inversely proportional to the square of its diameter. The figures obtained from circular plates are shown in fig. 25 A, B, C.

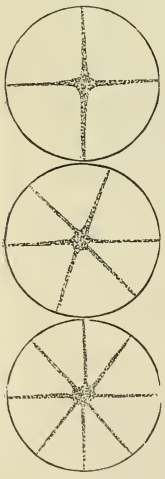


FIG. 25.

If some light powder, as lycopodium, be scattered upon a vibrating plate it is found that it collects, not upon the nodal lines, but in little heaps upon the vibrating segments. This is owing to the fact that currents of air are set up by the vibration of the plates, and in these little whirlwinds a light powder is caught up and naturally deposited subsequently upon the parts where the vibration was greatest; a heavy powder, such as sand, would not be affected by these air currents. That this explanation is the correct one is shown by the fact that in a vacuum all powders, whether light or heavy, settle on the nodal lines. The effect of scattering a mixture of sand and lycopodium upon vibrating plates is shown in fig. 26.

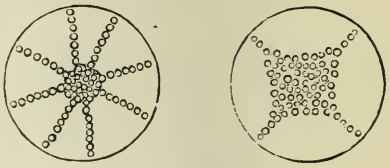


FIG. 26.

From a knowledge of the vibration of circular plates to those of bells is but a step, as a bell when vibrating always divides itself into four or any higher even number of segments, the nodal lines commencing at the mouth of the bell and running up towards the crown, where they cross. Fig. 27 shows the condition of the mouth of a bell when sounding its fundamental note, the dark line representing the mouth of the bell at rest, the dotted lines the positions which it alternately assumes during vibration. Where the hammer strikes the bell is the middle of a ventral segment, and 45° on each side of this point is a node, while the remaining half of the bell is similarly divided, so that there are in all four nodes (marked *n* in the figure). The number of segments corresponding to the fundamental note and the overtones of either a disc or a bell, together with the sequence of the notes produced, may be shown to be as follows:—

Vibrations of bells.

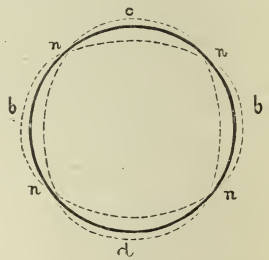


FIG. 27.

Number of divisions. .	4	6	8	10	12
Number of vibrations .	4	9	16	25	36

The lower row of figures will be seen to be the squares of the numbers 2, 3, 4, 5, 6.

The sonorous vibrations of bells may be rendered visible in a very beautiful manner by taking any ordinary bell-glass, such as is commonly used, and nearly filling it with water. Upon drawing a bow across the edge a note will be produced and the water will be thrown into the most beautiful ripples, the nodes and ventral seg-

How the vibrations of bells may be rendered visible.

ments being distinctly marked. Another method of showing the different points of maximum and minimum of vibration is the following:—Take a small pith ball and suspend it so that it just lightly touches the outside of the bell, and then draw the violin bow across the opposite side of the bell; the ball will be instantly and forcibly driven away. If, on the other hand, the ball hang at a node it will be repelled with much less force, but will still perceptibly move, the nodes of a bell being far less complete points of rest than in other musical instruments. If a bell glass is not at hand, an ordinary breakfast-cup, or even a jug, will serve very well to illustrate the above facts. A very beautiful way of rendering the vibrations of bells apparent is to fill a glass with warm alcohol or ether, and then sound it as before by means of a violin bow; the ripples of the liquid exhibiting the vibrations of bells. The same effect may be produced with a thin wine-glass and strong brandy.

The liquid and glass in the foregoing experiments vibrate together, and if any rupture of continuity take place the glass ceases to give out a musical sound. This is strikingly illustrated in the following simple experiment. Put a solution of carbonate of soda into a glass; upon striking the glass a clear musical sound is produced, but if you now add some tartaric acid so as to cause effervescence, and again strike the glass, a dead, unmusical sound is the only result, and this condition remains until the effervescence has ceased.

Effect of rupture of continuity of the liquid.

If a sounding tuning-fork be held over a jar or similar vessel a very considerable strengthening of the sound of the fork is noticed, and a few experiments will show that a tube of a certain length will resound more strongly to a particular fork than to any other of a different pitch. This strengthening of the sound of a note by an air column is known as *resonance*. If a tall jar be taken, the length of the air column which it contains can be varied by pouring into the tube varying quantities of water, the surface of the water being, of course, the base of the air column; in this manner we may determine the length of air column which resounds most perfectly to any particular fork. The best method to adopt is to sound a tuning-fork and hold it over a jar, adding water until the resonance is at a maximum; the height of the air column can then be determined by measuring the distance of the surface of the water from the top of the jar. Having ascertained the lengths of the respective air columns which resound to certain forks, upon comparing these lengths with the lengths of the sound-waves produced by the forks, it will be found that in every instance the length of the air-column is *one-fourth of that of the sound-wave*. We have already placed our readers in possession of the necessary information as to the method of ascertaining the wave-length of a sound from the number of vibrations producing it; the latter must of course be determined by means of the syren, or of Savart's wheel. The

Vibrations of columns of air, resonance.

explanation of the relation between the length of the air-column and the length of the sound-wave produced by the note to which it resounds will be understood on reference to fig. 28. Where a fork is placed over its resonant tube while the prong is moving from *a* to *b*, the condensation produced by it runs down to the

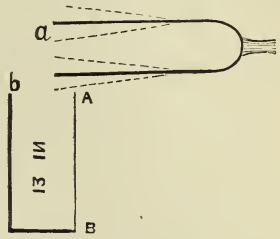


FIG. 28.

bottom of the jar, and is there reflected, the reflected wave meeting the prong just as it is starting from *b* to *a*. In like manner during the movement of the prong from *b* to *a* a rarefaction travels to the bottom of the jar, and its reflection meets the fork just as it reaches *a*. Hence the vibrations of the air-column are perfectly synchronous (Gr. *syn* = together, *chronos* = time) with those of the fork.

If a small tube the length of the air-column which resounds say to a C tuning-fork be blown across, as in fig. 29, a note will be produced which precisely corresponds to that of the fork (in this instance C), and this note is the fundamental one of the tube. By blowing more vigorously, higher notes, the overtones of the tube, may be produced. When the fundamental note is sounded it will be found that the column of air is undivided by a node, the bottom of the tube being a node, and the top the middle of a ventral segment. In sounding the first overtone, the column of air is divided into two parts by a node situated at one-third of the length of the tube from its open end; with the second overtone the column of air is divided into three parts by two nodes, the upper one being one-fifth of the length of the tube from its upper end. In every case the bottom of the tube is necessarily a node, and the top the middle of a ventral segment.

Closed pipes.

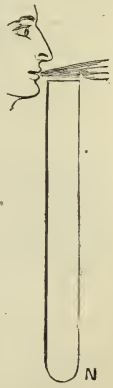


FIG. 29.

The number of vibrations of the fundamental tone and the overtones of a closed pipe is found to be in the order of the odd numbers 1, 3, 5, etc.; and the relation of the notes both in closed and open pipes may be easily remembered by means of the following rule:—*The number of vibrations is directly proportional to the number of semi-ventral segments.* The divisions of the air in a closed tube are sometimes diagramatically shown when sounding respectively the fundamental note and the first and second overtones. Here it will be

Succession of the notes of a closed pipe.

noticed that the numbers of *semi*-ventral segments are respectively 1, 3, and 5 ; the number

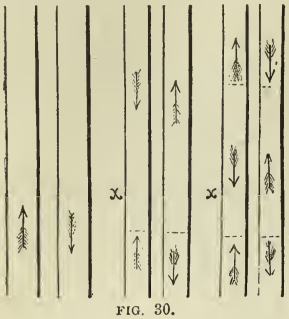


FIG. 30.

of vibrations will be in the same order. A little consideration will show that this must be the order of succession of the notes produced, as a column divided into three parts will necessarily vibrate with three times the rapidity of the same column when undivided.

A simple calculation.

We must next turn our attention to the behaviour of columns of air contained in pipes open at both ends. If we take a tuning-fork which produces a sound having a wave length of two feet, we shall find that the tube open at both ends which most strongly resounds to the fork is one foot long, and the same relation will always be found between the wave-length of a fork and the open tube which resounds to it—viz., that the latter is *half* the length of the sound-wave. From this it will be seen that the open tube which will resound to a given fork must be twice the length of the closed tube which resounds to the same fork. As in the closed tubes, the note which the open tube emits when caused to "speak" is the same as that of the fork to which it resounds.

Open pipes.

ENGLISH LANGUAGE AND LITERATURE.

VI.

CHAUCER AND HIS WRITINGS.

WE now come to the first English poet who may justly be called illustrious—a man who had travelled far before he wrote the great work with which his fame will ever be associated; who knew the men and manners of many nations; who was familiar alike with the palace and the cottage, the baron's hall, the tavern kitchen, and the lady's bower; who, patronized by the greatest of the land, and deemed not unworthy to be the companion of princes, yet could sympathize with men of every degree, and find the means of profitable enjoyment in company of every kind,—a man who, in his large appreciation, could discern the beautiful in nature and in art, in the visible creation and in the deepest emotions of the human spirit; who, to use the words of a later and more illustrious bard, could

Chaucer, the "father of English poetry."

> "Find tongues in trees, books in the running brooks,
> Sermons in stones, and good in everything."

The experiences of a long and eventful life, comprising much honour and high advancement, and not unchequered by misfortune; contact with the genius of Italy and the chivalry of other lands; and, above all, a cheerful, hearty, tolerant English spirit, contributed to the production of the immortal works of GEOFFREY CHAUCER.

"The Father of English Poetry" must be classed among the men whose genius, like generous wine, ripened with time. His greatest work was written in the evening of life, when he had reached the good age of threescore; and the wonderful knowledge of human character displayed in the *Canterbury Tales* is put before the reader invested with all the charms of flowing and harmonious versification, and clear and correct expression. His humour, sensibility, and pathos, are never so clearly exhibited as in this the last and greatest effort of his genius. "Posterity," says a judicious critic, "would have been interested in the history and genius of CHAUCER, who having long paced in a lengthened circuit of verbal version and servile imitation, passed through some remarkable transitions, kindling the cold ashes of translation into the fire of invention; from cloudy allegory breaking forth into the sunshine of the loveliest landscape painting; and from the amatory romance gliding into that vein of humour and satire which in his old age poured forth a new creation." The plain meaning of this is, that Chaucer, in his earlier works, copied the accredited models of the time—the metrical romances—and accordingly exhibits some of the frigid diction and artificial construction and treatment which characterized those works; just as Raphael at first was a copyist of his master, old Peter of Perugia, until his genius had learned to emancipate itself. But just as the Italian painter in time threw off the trammels of a borrowed mannerism, and appeared unfettered in his glory, so did the English poet at length strike out a new path for himself—a far loftier one than had been trodden by any of the old versifiers who preceded him.

The genius of Chaucer.

Of the parentage and early life of Geoffrey Chaucer little is known; and according to the general rule in such cases, attempts have been made to set up ideas by conjecture and by special pleading, when there was a scarcity of ascertained facts. Chaucer's tomb in Westminster Abbey gives us the date of his birth, 1328, and that of his death, 1400. From a reference in one of his works it has been supposed that he studied at the university of Cambridge; but Oxford also claims him for her own.

Particulars of Chaucer's life.

That Chaucer was a favourite at the court of Edward III. is certain. He married Philippa Pichard or de Rouet, whose sister ultimately became the wife of John of Gaunt; and Chaucer himself was a devoted adherent, for good and evil, of "time-honoured Lancaster." He took part in the wars of Edward III. on the

Continent, and was made prisoner by the enemy. The receipt for a sum of money paid for his release from captivity was discovered a few years since. An annual pension of twenty marks was settled upon him in 1367; and this sum represented a purchasing value of about two hundred and fifty pounds of our present money.

His visit to Italy.

A visit to Italy, to which country he was despatched on an embassy concerning state affairs in 1373, had a great effect on the genius of Chaucer. Italy had at that time already produced masterpieces of poetic literature: Dante had written his sublime *Divina Commedia*, in which Paradise, Purgatory, and Hell were unveiled to the reader's awe-struck mind. Petrarch had indited the sonnets that have made his name immortal, and Boccaccio's erratic and versatile genius had poured forth that wonderful *Decameron*, or collection of Ten Times Ten Tales, which under various forms and in various dresses furnished amusement to Europe for centuries. That Chaucer profited to the full by the intellectual wealth with which he now came in contact is abundantly proved by his works, and would have been patent, even without the pointed allusion of the poet, who in the prologue to the *Clerke's Tale* says to his audience:—

> "I wol you tell a tale, which that I
> Learned at Padowe of a worthy clerk,
> As preved by his werdes and his werk—
> Fraunceis Petrark, the laureat poete."

Various important offices, and the grant of a house in the royal manor of Woodstock, mark the rising fortunes of the poet towards the close of Edward III.'s time.

Chaucer's misfortunes.

With the reign of Richard II. came trouble for Chaucer. He was involved in difficulties arising from political and religious troubles. He was of the Wycliffite way of thinking, as abundantly appears in his description of the Monk, the Pardoner, and the Sompnour in the *Canterbury Tales;* and he attached himself to the party of a staunch Wycliffite, John Comberton. In consequence he was obliged to fly to Flanders, where he resided for some time. Some cause, probably want of money, brought him back to London. He was arrested, and imprisoned in the Tower; and in his prison, where "every hour appeared to be a hundred winters," he composed his poem *The Testament of Love.* He was obliged to make a somewhat abject submission and various disclosures before he obtained his liberty; and thus he has incurred a certain amount of odium, as a man who implicated his associates for his own private advantage. The author of the *Amenities of Literature*, however, energetically vindicates Chaucer from this imputation, and even doubts whether his imprisonment was connected at all with his partisanship of the Wycliffite and Lancastrian, John Comberton,—quoting the opinion expressed in Turner's *History of England*, that "There are other periods besides the one usually selected, to which the personal evils which Chaucer complains of are applicable." "Let us observe," says the author, "that in all these dark events the loyalty of the poet is never impeached; for Chaucer enjoyed without interruption the favour of both his sovereigns, Edward III. and Richard II.; and we discover that once, when dismissed from office, Richard allowed him to serve by deputy, which was evidence that Chaucer had never been dismissed by the king himself." The author goes on to conjecture that the whole transaction was due to an outbreak of party strife, and to the convulsive struggle of two opposing factions—those of the Dukes of Gloucester and Lancaster.

Closing years of Chaucer's life.

The last years of the poet's life were happier. Fortune smiled upon him again after the great Duke of Lancaster's return, and once more we find Chaucer a favourite, and a man holding important offices. In the reign of Queen Elizabeth "Chaucer's house" was still pointed out at Woodstock, in the royal domain; for to that quiet place it was that the author of the *Canterbury Tales* retired; and here, with a genius ripened by experience, and mellowed but not weakened by time, he wrote his immortal work. His favour increased with his years; for we find that nearly at the end of his life the pension he received from Richard II. was doubled. On Oct. 28, 1400, he died full of years and honours; and Westminster Abbey became the fitting resting-place for the remains of the Father of English Poetry. A distinguished English critic has well said of Chaucer: "In elevation and elegance, in harmony and perspicuity of versification, he surpasses his predecessors in an infinite proportion: that his genius was universal, and adapted to themes of unbounded variety: that his merit was not less in painting familiar manners with humour and propriety, than in moving the passions, and in representing the beautiful or the grand objects of nature with grace and sublimity. In a word, that he appeared with all the lustre and dignity of a true poet, in an age which compelled him to struggle with a barbarous language and a national want of taste; and when to write verses at all was regarded as a singular qualification."

Chaucer's English.

The service rendered by Chaucer to the English language, and the justness of the eulogium passed by an Elizabethan poet on his "well of English undefiled," will be at once understood if we compare Chaucer's versification and diction with that of his predecessors and contemporaries. His language is far richer than theirs; he practically exhibits how the plain Saxon tongue of his ancestors can be enriched by epithets and abstract terms culled from the Latin and the Norman-French. A comparison of his diction in the *Canterbury Tales* with that of Langland in *Piers Plowman*, or of Minot in his lays, will show this at once. Again, what a difference between the rude alliterative line of Langland, or the jingling metre of the metrical romances, and the lofty yet flowing decasyllabic line, introduced by Chaucer, and unanimously accepted down to the present time as the one best suited to the genius of the English language for epic,

dramatic, and descriptive poetry! Again, if we compare the artificial heroes and heroines of Chaucer's predccessors, at best but personifications of some separate quality or feature, with the downright, real, flesh-and-blood personages whom Chaucer makes to ride forth on that famous journey to Canterbury, the pre-eminence of Chaucer appears more clearly than ever. He wrote of a real England,—of the hedgerows, the flowers, and the birds; he peopled a country he had himself seen with characters as real as the scenery; and substituted for the false brilliancy of a conventional and artificial world the true and shining glories of nature. In his works we have a good criterion of the advance of the English language towards literary completeness. The prefixes and affixes of the verb are falling away; the spelling of the words is shortened. The choice of terms is greatly enlarged, and the influence of the French pronunciation is seen in the accent thrown on the last syllable of many words, in imitation of the French tonic accent. With him a fiddle is *fidèl*, supper, *soupére;* mastery, *maistrie*, psaltery, *sautrie*. Still, in his time, we find many words pronounced as dissyllables that have since been contracted into monosyllables; thus rich and new are *riché* and *newé;* name, *namé*. The *y* as the prefix in the past participle is still in many instances retained, and likewise the old *en*, the sign of the infinitive; as in "he was yslain;" "to tellen you;" "he was late ycome to speken." In the same way many of our dissyllables are trisyllables with Chaucer. A number of words from the Provençal became naturalised by his means.

His power of depicting character.

Peculiarities of his versification and style.

The earlier works of Chaucer are chiefly translations from the French: the poet seems at first to have followed his originals pretty closely; but as his genius expanded, his thoughts and expressions became more original, as with a great mind was no doubt to be expected. But the detailed consideration of the works of Chaucer must be delayed to our next article.

ZOOLOGY.

XXII.

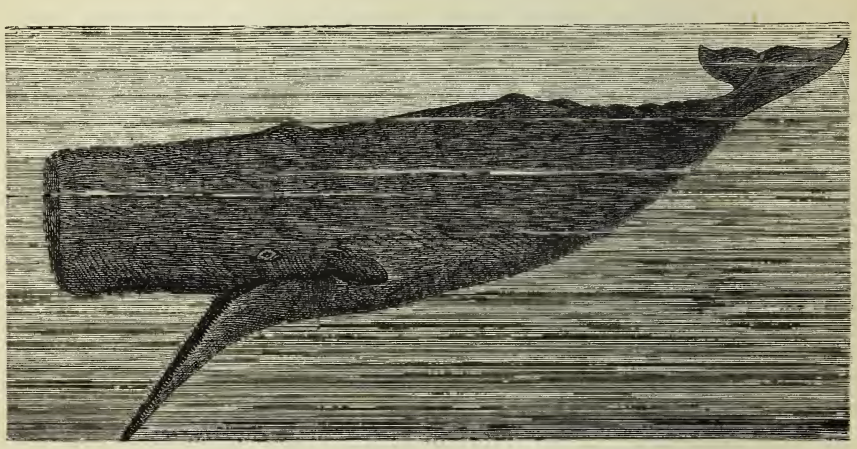
Order Cetacea; Whales and Dolphins.

The study of the marine carnivora has made us familiar with the idea of mammals spending most of their time in water. We must now turn to a group quite incapable of life upon land, although air-breathers and warm-blooded, bringing forth their young alive, and suckling them.

Unfitness for life on land.

The whales and dolphins are found in all seas, and in some large rivers, such as the Ganges and Amazon. In form they are considerably like massive fishes, but they are at once distinguishable from them by the tail-fin being horizontally placed. Then, too, their skin is smooth,

Tail-fin, smooth skin, blubber.



POTWAL.

not covered with scales, and a thick layer of fat lies beneath it, which is called blubber, and which supplies the whale-oil of commerce. When the skin of an ordinary whale is examined, it appears to depart notably from the rule in most mammals, in having no hairs, but these are present before birth if not after. The head is frequently very large in proportion to the body, sometimes occupying one-third of the total length. There is no perceptible region to be called a neck, and the resemblance to a fish is often increased by the skin of the back being produced into a dorsal fin. The appearance of only one pair of limbs at the sides of the body behind the head—mere paddles covered with skin, not retaining any plain distinction of fingers, as if a hand enclosed in a bag were fixed to the skin—serves to confirm our assurance that we have to deal with no ordinary group of creatures.

No neck.

One pair of limbs.

Notwithstanding the great size of the head, the brain-cavity is by no means large in proportion; yet in some we find an extremely com-

plex folding of the brain substance, as in porpoises. The principal length of the skull is made up by the jaw-bones, the part in front of the opening of the nostrils being especially lengthened. This corresponds with an extremely convenient arrangement by which the opening of the nostrils is placed right at the top of the head. Thus the whales are enabled to breathe air when almost the whole of the body is submerged. They do not use the mouth for breathing, and as there appears to be little, if any, need for a modulated voice, there is no obstacle to the existence of a very remarkable arrangement by which the windpipe is lengthened and kept always grasped by the back of the soft palate. Thus there is formed a channel to the top of the head where the blow-hole is situated, closed when not actually in use for breathing out and in. The operation of blowing, or expiration, is usually attended with a rush of spray, partly due to the raising of surrounding water, but principally consisting of

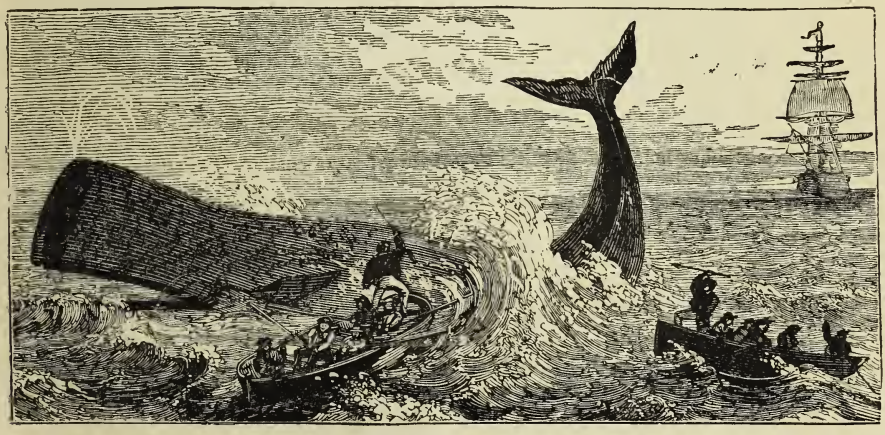
Long jaws.

Blow-hole.

furnished with peculiar growths from the palate, called whalebone or baleen plates. These hang down from many transverse ridges into the mouth, and have much in common with hairs, nails, and horns. They are longest on the outer sides of the palate, and gradually diminish to nothing towards the centre, leaving a free space along the middle. The lower ends of the plates are frayed out into a fringe of hair-like processes, which naturally lie against the sides of the huge tongue. How can this extraordinary arrangement be advantageous to the whale? When the creature opens its mouth it necessarily becomes filled with water, which contains many nutritious animals, —molluscs, crustaceans, etc. When the mouth is closed again, the water is strained off through the frayed-out edges, leaving the living prey of the whale deposited upon the tongue ready for swallowing. Thus it is that the whale without teeth can be as truly carnivorous as the most fierce-looking land tyrant. Like nails, too, the

Whalebone.

Feeding.



SPERM WHALE.

the condensed moisture from the air in the lungs. The mouth is left free for its principal work of food-getting, without any danger of the water entering the lungs. The stomach is usually complex—that is, divided into three or more cavities, the last of which is the special digestive stomach. The heart is large and powerful. The tail is moved with great force, not merely by muscles placed near it, but by means of tendinous cords, by the great mass of the muscles of the trunk, both of the back and belly. Finally, as the presence or absence of teeth gives rise to the most available means of subdividing the order, we will refer at once to the

Complex stomach.

Strong tail.

Toothless Whales.

Even these have teeth in the embryonic condition, which never cut the gum. thus showing how prevailing is the unity of structure in mammals; a fact which many regard as strongly indicative of the descent of all from common ancestors. Instead of teeth, these whales are baleen plates continue to grow from the roots through life, and the ends are always kept frayed out.

The Right or Greenland Whale is the best-known form, the most valuable for baleen and blubber. This and others closely related have no fin on the back, while the Humpbacks, with long flippers, and the Fin Whales or Rorquals have one. All reach a large size, the right whales attaining sixty or seventy feet, the fin whales even a hundred feet in length. An average-sized whale will yield half a ton of baleen and seventy barrels of oil. Baffin's Bay is a great seat of the whale fishery, pursued in steam vessels. The whales are sought when they come to the surface to breathe, and transfixed with harpoons by men skilled in hurling. The whale will often dive very rapidly to a great distance, but must return to the surface, becoming gradually exhausted by repeated strokes and loss of blood. It is sometimes very dangerous to the boats' crews engaged in the capture.

Length.

Whale fishery.

There is no doubt that the whales display great affection for their offspring, and that they are capable of fun and frolic. They feed chiefly upon very small molluscs belonging to the wing-footed group. The rorquals feed on larger creatures, such as herrings, of which several hundreds have been found at one time in their stomachs.

The Toothed Whales.

Among these the Sperm Whale or Cachalot is the most important commercially, rivalling even the Whalebone Whales, on account of the great development of the peculiar fat known as spermaceti in a huge cavity between the bones of the upper jaw and forehead. These bones are so raised in ridges as to form a most remarkable basin, open in front. The skull is in several respects very unsymmetrical, corresponding bones being of different shapes on the two sides of the head, and the whole skull forming a curious object of study. In the upper jaw the teeth do not protrude, but in the lower there is a long row of very numerous conical teeth. The upper jaw overhangs the lower, and the two halves of the latter are united in the front half of their length. Of the sixty feet, which is a cachalot's ordinary length, nearly one-half is taken up by the enormous head. The hand-fins are short, the eyes are minute, and the blow-hole has but a single opening.

Conformation of head.

All the oceans are visited by cachalots, which herd in considerable though diminishing numbers, and habitually migrate. They are most abundant in various parts of the Pacific Ocean, and are there principally sought by American and British whalers. At times they display great faculties of resistance, destroying or upsetting boats with ease. Their throat is much wider than that of whales, and consequently they can despatch larger prey, such as fishes, cuttlefish, and the like. Sharks and killer-whales are, however, serious enemies, against whose attacks they cannot well defend themselves.

The Bottle-nosed Whales are much smaller than these, not usually exceeding twenty-five or thirty feet in length; they were in former ages much more numerous in species and individuals. The snout is slender instead of attaining the great protuberance of the sperm whale; and the lower jaw has but one or two pairs of perfect teeth. From the stomach of one form caught off New Zealand in 1868, half a bushel of the beaks of a species of octopus was taken, showing how persistent an enemy of these sea-ravagers it must be. Cuttle-fish, and other forms of destructive mollusca, are the chief food of other members of this group.

Bottle-nosed whales.

In nearly all the Dolphins, Porpoises, and Grampuses proper, there are numerous similar teeth in both jaws. In the dolphins these may reach two hundred, having enamelled crowns adapted for catching and holding fish—not set in distinct sockets, but in an imperfectly divided groove. The common porpoise, about five feet long, is met with in shoals, which are most destructive of mackerel and herrings in nearly all seas. The killer-whale is a true grampus, and has fewer and larger teeth, capable of destroying almost any kind of fish, and often directed against various of the largest members of its own order, the whales. They reach thirty feet in length, and a single individual has been found containing in its stomach thirteen porpoises and fourteen seals. Their voracity and ferocity are truly astounding, and could hardly be surpassed by the fiercest tigers or wolves. Seals and walruses they have almost entirely at their mercy. They are easily distinguished by the whiteness of their belly and the blackness of their upper skin.

Dolphins and porpoises.

Grampuses.

Voracity of killer.

The so-called Unicorn of the sea, the Monodon or Narwhal, is the most peculiar of all dolphins in its teeth, for it has but two, a pair of long canine tusks in the upper jaw, one of which is commonly undeveloped, the other giving rise to the name unicorn. In the female both these teeth remain little developed and concealed. In the male, one—almost always the left—is developed to the length of four or five feet, being marked by a spiral groove from end to end. It is almost entirely of dentine without any coat of enamel. Being an Arctic form, it would appear that the tusk is of value in keeping the ice-holes open to enable them to come to the surface to breathe.

The sea unicorn.

The Beluga or White Whale, and the Caaing or Pilot Whale, are other interesting forms. The fresh-water dolphins are found in three distinct genera—the Gangetic Dolphin, also inhabiting the Indus, the Amazon Dolphin, and the Dolphin of the La Plata river system. The latter has a long beak, and has two hundred and twenty teeth in all, the largest number found in any mammal. The Gangetic dolphin has an exceedingly long and narrow snout, with many long-pointed teeth. The eyes are so small as to be scarcely perceptible, and the openings of the ears are very minute. They feed on fresh-water fishes and crustaceans.

Fresh water dolphins.

HOW TO ENTER THE CIVIL SERVICE.

I.

THE term Civil Service is a very comprehensive one. It includes all situations under Government which are not strictly military or naval, from that of the Prime Minister as First Lord of the Treasury down to the humble position of messenger, porter, or charwoman in

a Government establishment. The qualifications required, methods of appointment and emoluments, necessarily vary, and our purpose is to give some information upon each of these points, so far, at all events, as relates to the great bulk of the situations open to the public. Appointments to high political office will not concern us here. Our task is at once more modest and more practical, being simply to assist young men and women who desire to enter the Civil Service and want to know how it is to be done. For young women we are sorry to say there are at present but few situations open,—mainly telegraphic and other clerkships in the post office,—and these we shall speak of further on. The details given here refer to situations open to young men.

Civil Service Clerkships.

Ordinary Civil Service clerkships are divided into two distinct and separate classes—a Higher Division and a Lower Division. Upon this point it is essential that there should be no misunderstanding. The Higher Division candidates have to show the possession of superior qualifications and to pass a severe examination. When appointed they are required to undertake the higher and more responsible work of the departments in which they are engaged, and they receive corresponding pay. The rate of remuneration, however, is by no means excessive considering the qualifications required. The salary of a clerk in what is called the "New Higher Division," which comprises the bulk of the appointments now made in Class I., commences at £100, and rises by triennial increments to £400,—that is, supposing he obtains no advancement, of which there are many opportunities. There are, for instance, staff appointments, including such positions as those of "chief clerks" and "principal clerks" with increased salaries, and "duty pay" is awarded to clerks who are required to undertake special duties with increased responsibilities. Besides which, social position, the permanency of a Government situation, and the prospect of a pension, go for something in the calculation.

For clerkships in the Lower Division the qualifications required are not so high; the duties are less onerous and more matters of routine, and the salaries lower. These commence at £80, and rise by increments of £15 every three years to a maximum of £200. In any office where a regular attendance of seven hours a day is required, salaries commence at £95, and may increase to £250. As in the Higher Division, extra pay is attached to certain more responsible positions—such, for instance, as situations involving the superintendence of other clerks—but in this division no such extra pay can exceed £100 per annum.

As a rule there is no way open from the Lower to the Higher Division. The candidate who elects to enter by the easier door into the lower grade must make up his mind to remain in it. Exceptional promotions to the higher division of the service are made, but these cannot take place without a special certificate from the Civil Service Commissioners, to be granted *exceptionally* after not less than ten years' service, upon a special recommendation from the head of the department, and with the assent of the Treasury.

The Lower Division includes boy clerkships, which are also filled by competitive examination. Boy clerks cannot retain their situations after the age of nineteen, but are allowed to compete amongst themselves under certain conditions for men clerkships. Boy clerks begin with a salary of 14*s.* per week, and rise by 1*s.* per week per annum as long as they are employed.

Examinations.

The Civil Service Commissioners have the power to arrange for examinations whenever and wherever they may think fit. Under present arrangements four for the selection of Lower Division clerks are held every year in London, Dublin, and Edinburgh, and of these and other examinations due notice is given in the *London Gazette* and in the principal newspapers. The advertisements in the London papers usually appear on Thursdays. When the announcement that an examination is to be held has appeared,—but not before,—any person wishing to present himself as a candidate must make application by letter for permission to attend the preliminary examination. This letter must be in the applicant's own handwriting, and should be addressed to the Civil Service Commissioners, Cannon Row, Westminster. In reply, full instructions will be forwarded as to the time and place, fees, etc. Should he pass this examination satisfactorily, the candidate will be allowed to enter the competitive examination. There is a very courteous clerk in attendance daily at the inquiry office in Cannon Row, from whom all necessary information may be obtained; but no telegraphic communication will be attended to, and the Commissioners will not undertake to answer inquiries relating to cases not before them for decision, and only in the cases of actual candidates are they willing to decide questions respecting the application of published rules and regulations. They also decline to advise candidates as to the "course of preparation" they should follow, and any persons seeking information as to duties, salaries, course of promotion, pensions, etc., are referred to published documents.

The following are the General Regulations under which competitive examinations are held. We shall give the *special* regulations in subsequent articles.

General Regulations.

1. Competitive examinations of candidates for situations in the different public departments will be held at such times and in such places as may be deemed expedient. Before every such examination special regulations will be issued, in which the particular conditions of the competition will be specified.

2. These examinations will have reference either to the vacancies existing at the time of the examinations respectively, or to the number which may be estimated to occur within any period not exceeding six months after the commencement of the examinations, as may be laid down in special regulations, or in any notice of such examinations published, with the approval of the Lords of the Treasury, in the *London Gazette*.

3. These examinations are open, under such general restrictions as may be laid down, to all natural-born subjects of Her Majesty, being of the requisite age, health, and character. The under-mentioned restrictions are at present in force:

(i.) Persons actually serving in the army and navy are ineligible.

(ii.) The following classes of persons are eligible under certain conditions only, that is to say:—

(*a*) Persons holding situations in the Civil Service.

(*b*) Members of the Royal Irish Constabulary, of less than twelve years' service.

(*c*) Apprentices and engineer students in Her Majesty's dockyards.

(*d*) Persons who have been trained in normal schools at the public expense.

Persons comprised in the classes (*a*), (*b*), (*c*), must have produced to the Civil Service Commissioners, before the date of the competition, the written permission * of the authorities of their department to attend the examination.

Persons comprised in class (*d*) will not be qualified to receive appointments until the consent of the Committee of Council on Education, Great Britain, or the Commissioners of National Education, Ireland, as the case may be, given in conformity with rules sanctioned by the Lords of the Treasury, has been notified to the Civil Service Commissioners.

4. In reckoning age for competition the following allowances will be made—viz., (1) members of the military and naval services (whether commissioned or non-commissioned) may deduct from their actual age any time during which they have served towards pension; (2) persons who have served for two full consecutive years (*a*) in any civil situation to which they were admitted with the certificate of the Civil Service Commissioners, (*b*) in the Royal Irish Constabulary, or (*c*) as registered copyists in connection with the Civil Service, may deduct from their actual age any time not exceeding five years which they may have spent in such service.

5. If at any examination two or more situations, whether in the same or in different Departments, shall be offered for competition, the successful candidates will be permitted (unless otherwise stated in special regulations) to choose, in their order as determined by the competitive examination, among the situations offered for competition; provided that they be duly qualified, according to the special rules prescribed, under Clause IV. of Her Majesty's Order in Council of 4th June, 1870, for the particular situations to which they may severally be assigned. If there be a vacant situation for which no one of the successful candidates is duly qualified, the Civil Service Commissioners may offer it to the highest candidate on the list whom they may deem duly qualified, or to the candidate highest at the time on the list, subject to his passing a qualifying examination within such period as they may determine; or they may reserve it to be filled by means of a subsequent open competition, or otherwise, as they may in their discretion see fit, in accordance with the Order in Council of 4th June, 1870.

BOSTON (*from an old print*).

* It is desirable that this permission should be produced at least one week before the date of the competition.

POLITICAL GEOGRAPHY.

XV.

UNITED STATES.

THE United States of North America occupy the most valuable portion of this continent, between lat. 25° and 49° N. and long. 67° and 125° W. It extends from Canada on the north to Mexico on the south, and from the Atlantic on the east to the Pacific on the west. Its greatest width between the two oceans is 2,500 miles, and from north to south it measures about 1600 miles. Area 3,002,852 square miles; in addition to which is the inhospitable territory of Alaska in the north, which has an area of 577,390 square miles. The territory of the

United States is traversed by the principal mountain chains, the Alleghanies in the east and the Rocky Mountains in the west. These divide the country into three distinct geographical regions,—the Atlantic slope, the valley of the Mississippi, and the declivity from the Rocky Mountains to the Pacific. The Atlantic slope, owing to its favourable position for trade and commerce, its fertile soil and navigable rivers, its mines of iron and coal, is the seat of the greatest manufacturing industries of the States. The valley of the Mississippi stretches from the western slope of the Alleghanies to the eastern base of the Rocky Mountains, and comprises fully half the area of the States. Agriculture is here the chief pursuit. In the north wheat and maize are the principal crops, and in the south, cotton, rice, tobacco, and sugar. Between the Rocky Mountains, the Sierra Nevada and the Coast Range, occur elevated plateaux and basins, one of which, the Great Basin of Utah, has an area of about 13,000 square miles, and contains the Great Salt Lake. From the Sierra Nevada and Coast Range, the Pacific slope averages 150 miles in width. The country abounds in wild and majestic scenery; vast forests of huge trees occur; gold, silver, and other metals abound; and the inhabitants are chiefly employed in mining, agriculture, and forestry. The States have a great diversity of climate. It may generally be characterised as moist and variable. In the south it partakes of a tropical nature, while in the north a severe winter lasts for four or five months in the year. On the coasts of the Pacific it is much milder than on those of the Atlantic under the same parallels. The mineral wealth of the country is very considerable. Coal and iron are widely distributed, and so are lead, copper, and tin. Gold is very abundant in California, and silver, mercury, and diamonds are also found. Salt is obtained from numerous springs in the state of New York and other parts. The great body of the people are employed in agriculture. The principal crops are oats, wheat, rye, maize, buckwheat, barley, potatoes, sugar, cotton, tobacco, rice, hemp, and flax. The rearing of cattle and the making of dairy produce are also largely carried on. The total value of exports in 1881 was £184,356,839, of which to United Kingdom £107,081,260; of imports £150,648,025, of which from United Kingdom £37,954,192. The coasting trade is very extensive, and a vast number of steamers and other craft are constantly plying the navigable rivers and lakes. In 1881 there were 93,671 miles of railway in operation; the Great Pacific Railroad, connecting San Francisco with New York, was opened in 1869.

PHILADELPHIA (*from an old print*).

The Union consists of thirty-eight sovereign states, one federal district, and eight organized territories, besides the Indian territory and the territory of Alaska. The states are:—*North Atlantic, or New England*—Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut. *Middle Atlantic*—New York, New Jersey, Pennsylvania, Maryland, Delaware, (District of Columbia). *South Atlantic*—Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida. *North Central*—Kentucky, Ohio, Indiana, Michigan, Illinois, Wisconsin, Missouri, Iowa, Minnesota, Kansas, Nebraska, Colorado. *South Central*—Alabama, Mississippi, Louisiana, Texas, Arkansas, Tennessee. *Pacific*—California, Nevada, Oregon. The organized territories are New Mexico, Arizona, Utah, Wyoming, Dakota, Montana, Idaho, Washington. Population (1880) of states, 49,547,233; of territories, 605,633; of Indian territory, 78,310; Indians, 177,628; Alaska territory, 30,146; total 50,438,950. The principal towns with their populations are—New York, 1,206,590; Philadelphia, 846,984; Brooklyn, 566,689; Chicago, 503,304; Boston, 362,535. The executive power is vested in a President, elected for four years: the legislative in a Congress, composed of a Senate and House of Representatives—the former consisting of 76 members, two for each state, elected by the legislative thereof for six years; the latter of 293 representatives, elected by popular vote, for two years, in the proportion of one representative for every 135,239 of the population. In 1881 the revenue amounted to £72,156,458; the expenditure, £52,142,577; public debt, £411,367,671. The army consists of 2,085 officers and 25,500 men; the navy of 140 vessels with 1022 guns, and 10,285 officers and men. The prevailing religious sects are Methodists, Baptists, Presbyterians, Congregationalists, Episcopalians, Lutherans, and Roman Catholics. No sect is endowed by the State. Education is universally diffused, and schools and colleges are numerous. In 1879 the State expended for public schools £15,638,806.

Mexico.

Mexico occupies the south-western portion of North America, between lat. 16° and 33° N., and long. 87° and 117° W., and has on the north the United States; east, the Gulf of Mexico and the Caribbean Sea; south, Guatemala; and south-west and west the Pacific Ocean. Area,

741,820 square miles ; and population 9,656,668, of whom about 1,000,000 are whites and 4,000,000 Indians, the rest being chiefly of mixed race. The surface of the country is extremely varied. It commences to rise at a few miles from the coasts, and the greater part of the interior consists of a series of plateaus from 4,000 to 8,000 feet above the sea, with mountain ranges of a volcanic nature, some of whose summits rise to the height of more than 17,000 feet. The soil is generally fertile, though a considerable portion of it is unfit for cultivation. The climate varies greatly according to the elevation, and is usually divided into hot, temperate, and cold. The low-lying coast-land presents all the characteristics of a tropical country, and indigo, cotton, the sugar-cane, bananas, and other tropical products are found. This region, however, is very unhealthy. From 2,000 to 5,000 feet above the sea the vegetation of the temperate zone prevails, and the cereals and fruits grown in Europe are produced. Above this a gradually cooler region is reached, and the summits of some of the highest mountains are continually covered with snow. Medicinal plants are very numerous, and mahogany, rosewood, ebony, and other valuable trees abound. The mineral wealth of the country is very great, including gold, silver, iron, copper, lead, tin, mercury. The principal exports are gold, silver, and other metals, drugs, sugar, flour, indigo, timber, tobacco, coffee, hides,—the total value being about £6,000,000. Agriculture and mining constitute the chief occupations of the people. There are 873 miles of railway in operation.

Mexico is a confederate republic, consisting of twenty-seven states, one territory, and one federal district. The executive is vested in a President, elected for four years, and the legislative in a Congress consisting of a Senate of 56 members, or two for each state, elected for four years, and a Chamber of Deputies of 227 members elected for two years. Army about 20,000. Estimated revenue for 1882, £5,145,000 ; expenditure, £7,918,340; public debt, £28,990,757. Capital, Mexico, with 242,000 inhabitants.

Central America.

Central America is the southern portion of the continent of North America, extending from Mexico to the Isthmus of Panama, and lying between lat. 8° and 18° N., and long. 82° 30′ and 93° 30′ W. It is about 900 miles in length from north-west to south-east, and from 70 to 300 in width, and has an area of 164,900 square miles. A range of no great elevation extends longitudinally through the country, dividing it into two unequal portions, the smaller being towards the Pacific. The course of this range is interrupted in several places, especially by two cross valleys, one of which contains the lake of Nicaragua, the other the plain of Comayagua. Some of the summits of the range rise to 12,000 and 13,000 feet, and many of them are volcanoes. The climate, like that of Mexico, varies with the elevation of the surface, and the vegetable productions belong both to the torrid and temperate zones. The forests are extensive, and comprise mahogany, logwood, and other valuable woods. Among the other products are cotton, coffee, sugar, rice, maize, wheat, cochineal, indigo, cocoa, sarsaparilla, tobacco. The chief employments of the people are agriculture and cattle-rearing. There are mines of gold, silver, copper, iron, zinc, lead ; and other metals are found. The country is divided into five independent states, which, with their areas and populations, are as follows :—Guatemala, area 40,776 sq. m., population 1,500,000 ; San Salvador, area 7,335, population 554,000 ; Honduras, area 39,600, population 300,000 ; Nicaragua, area 58,170, population 250,000 ; Costa Rica, area 26,040, population 200,000. Besides these there is the small colony of British Honduras, with an area of 6,500 square miles and a population of 27,452.

L.

Study for Practice in the Recognition of the Irregular Verbs and for Reading and Pronunciation.

(N.B.—The list of the irregular verbs occurring in this study, and given at the end of the German reading, should be learnt by heart.)

Wie König Friedrich der Große von
vee köh'-nich freed'-rich dare gross'-e fon
How King Frederick the Great of

Preußen in Berlin ausfuhr und ausritt.
proiss'-en in bare-leen' owss'-foor unt owss'-ritt
Prussia in Berlin drove out and rode out.

Bis in sein spätestes Alter[1] ritt
biss in zine spay'-test-es all'-ter ritt
Till in his latest age rode

Friedrich der Große in Potsdam stets[2]
freed'-rich dare gross'-e in pots'-dam stayts
Frederick the Great in Potsdam always

und fuhr niemals. Er schien dieses für
unt foor nee'-mahls airr sheen dee'-zes für
and drove never. He seemed this for

eine Schmach und eines Soldaten un-
i'-ne shmaach unt i'-nes zol dah'-ten un'-
a shame and of a soldier un-

würdig zu halten. Nur in den vier
vuer'-dich tsoo halt'-en noor in dane feer
worthy to hold. Only in the four

Wochen, in denen er sich alle
voch'-en in dayn'-en airr zich al'-le
weeks in which he himself all (every)

Jahre während des Carnevals in
yahr'-e vairr'-end dess cahrr'-ne-vals in
year(s) during the Carnival in

Berlin aufhielt,[3] fuhr er und zwar
bairr-leen' onf'-heelt foor airr unt tsvahr
Berlin tarried, drove he and indeed

immer im königlichen Pomp.[4] Voran
im'-mer im köh'-nich-lich-en pomp for'-ahn
always in royal pomp. In front

gingen acht Läufer mit ihren Stäben,
ging'-en acht loy'-ferr mit eer'-en stay'-ben
went eight runners with their staves,

Federmützen und Läuferschürzen in
fay'-der-mütz-en unt loy'-fer-shurtz'-en in
feather caps and runner's aprons in

zwei Gliedern.[5] Da diese aber
tsvy glee'-dern dah dee'-ze ah'-ber
two ranks. As these however (at)

sonst gar nicht gebraucht wurden,
zonst gahr nicht ge-browcht' voor'-den
other (times) not at all used were

so war es ein Versorgungsposten[6] für
zo vahr ess ine fer-zor'-goongs-poss'-ten führ
so was it a provision post for

Invaliden aus der Garde. Daraus
in'-vah-lee'-den owss dare garr'-de dah'-rouss
pensioners from the guard. Therefrom

folgte, daß der König auch immer
folch'-te dass dare köh'-nich owch im'-mer
followed that the king also always

im langsamen Schritt fahren mußte.
im lang'-sah-men shritt fah'-ren moos'-te
in slow pace to drive was obliged.

Seine Wege[7] waren aber keine andern,
zy'-ne vay'-ge vah'-ren ah'-ber ky'-ne an'-dern
His routes were however no others,

als vom Schloße in die Oper wöchent-
alss fom shloss'-e in dee op'-per vöch'-ent-
than from the palace into the opera week-

lich[8] zwei mal und während des ganzen
lich tsvy' mahl unt vairr'-ent dess gants'-en
ly twice (two times) and during the whole

Aufenthalts ein oder zwei mal zum
owf'-ent-halts ine oh'-der tsvy mahl tsoom
stay one or two times to the

Prinzen Heinrich und zu der Prinzessin
prints'-en hine'-rich unt tsoo dare prints-ess'-in
Prince Henry and to the Prince

Amalie. Dann ruhten die Läufer
ah-mah'-li-ay dann rooh'-ten dee loy'-ferr
Amelia. Then rested the runners

wieder ein Jahr lang. Hinter ihnen
vee'-derr ine yahr lang hinn'-ter ee'-nen
again a year long. Behind them

kam dann der achtspännige[9] königliche Wagen mit acht Fenstern rund herum, die Pferde, mit altmodischen Geschirren[10] und Federbüschen auf den Köpfen; Kutscher und Vorreiter in der damaligen königlichen Livree, blau, Kragen, Aufschläge,[12] Taschen und
kahm dann dare acht'-spen-niche köh'-nich-e li-che vah'-gen mit acht fenns'-tern roont hair-oom' dee pfairr'-de mit alt'-moh-dish-en ge-shirr'-en unt fay'-der-büsh'-en owff dane köpp'-fen kutt'-sher unt fore'-ry-terr in dare dah'-mah-lich-en köh'-nich-lich-en liv-ray' blough krah'-gen owff'-shlay-ge tash'-en unt
came then the eight-horse kingly carriage with eight windows round about, the horses, with old-fashioned harness and feather-plumes on the heads; coachman and outriders in the of that time royal livery, blue, collar, facings, pockets and

alle Näthe mit einem rothen Tuchstreifen
al'-le nay'-te mit i'-nem roh'-ten tooch'-stry-fen
all seams with a red cloth stripe

besetzt, dieser aber wieder mit zwei
be-zetst dee'-zer ah'-ber vee'-der mit tsvy
edged, the latter however again with two

schmalen goldenen Tressen eingefaßt,[13]
shmah'-len gol'-den-en tres-sen ine-ge-fasst
narrow golden stripes edged,

was sehr gut aussah. In den vier
vas zayr goot owss'-zah in dane fearr
which very well looked. On the four

Nebentritten der Kutsche standen
nay'-ben-trit'-ten dare koot'-she stand'-en
side-steps of the coach stood

vier Pagen, roth mit Gold, seidenen
fear pah'-gen rote mit gollt zy'-den-en
four pages, red with gold, silk

Strümpfen und Federhüten, hinten
strümp'-fen unt fay'-der-hüh-ten hint'-en
stockings and feathered hats, behind

der Bediententritt[14] leer und
dare be-deen'-ten-trit lairr unt
the servant's standing-place empty and

hinter demselben, unten, wo man
hin'-terr dame-zel'-ben oon'-ten voh man
behind the same, below, where one

zu dem Bediententritt aufsteigt, stand
tsoo dame be-deen'-ten-tritt owff'-stygt stant
to the servant's stage up steps, stood

ein Stallknecht.[15] So bewegte sich der
ine shtall'-knecht zo be-vayeh'-te zich dare
a groom. So moved itself the

Zug langsam vorwärts, aber stets
tsooch lang'-sam fore'-vairts ah'-ber stayts
procession slowly forwards, but always

durch eine große Maße von Menschen,
doorch i'-ne gross'-e mass'-e fon mensh'-en
through a great mass of people,

die zu beiden Seiten eine Gaße bildeten;
dee tsoo by'-den zy'-ten i'-ne gass'-e bil'-de-ten
who on both sides a lane formed;

Alles blickte nach dem Könige in
al'-les blick'-te nach dame köh'-nich-e in
all looked at the king in

Ehrfurcht[16] und Stille.
airr'-foorcht unt shtil'-le
respect and silence.

(*For Notes see Article* LI.)

XLV.

Rome (*continued*).

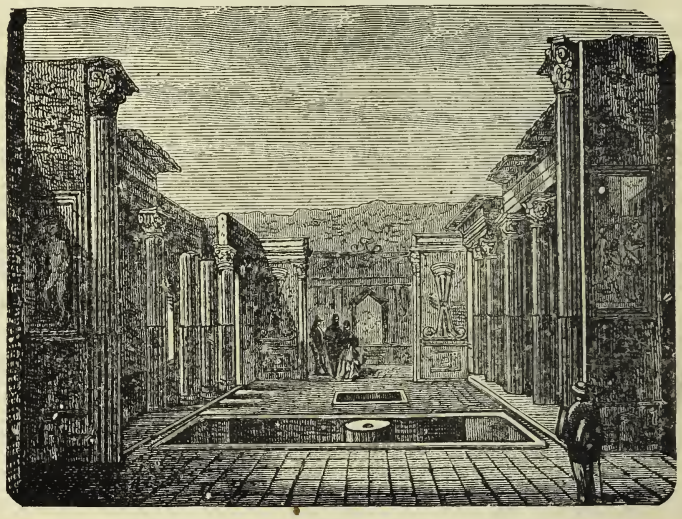
From the time at which we concluded our last article onwards, the wars of Rome were against the "barbarians" who lived on the outer borders of her empire. Now, for the first time, our forefathers, as well as those

of the French and Germans and Russians. came in contact with the power of Rome, As we read on we shall find how these barbarians were in most directions gradually driven back at first, and so long as Rome was in her prime; but in the course of time we shall see them learning Rome's methods of warfare, and gradually regaining their old ground.

From the destruction of Carthage we may also note a gradually growing departure of the Romans from their old manners and customs. Their simplicity and sturdy honesty and independence give place more and more every year to luxury and corruption among the rich, and idleness and love of amusement among the poor. The inequality of wealth became greater every year. The farmer class, from which in early times were drawn the sturdy soldiers who beat back the Gauls and Carthaginians, had, by long war, been reduced to poverty, and driven to sell their farms and live as artisans and labourers in the cities. The rich men bought up these lands and cultivated them by means of slaves. The city of Rome became crowded with a great population of idle, lazy paupers. And yet these pauper citizens of Rome elected all the magistrates. The candidates for office were the rich, and they had to ingratiate themselves with the electors by presents and favours of all kinds. Doles of corn began to be distributed gratuitously among the people in ever increasing quantities. Then the people cried out for amusements as well, and candidates had to supply them with these at enormous cost. The chief of these amusements were shows of wild animals and curious objects sent from the distant provinces in Asia and Africa. Then these animals were set to fight and kill each other in the great circuses; and soon men began to engage in combat with wild beasts, and finally men fought with men, and great battles, with hundreds of men on each side, used to take place, and human blood was shed as freely as that of pigeons and pheasants now-a-days, to amuse and bribe the electors of Rome. The fights were called gladiatorial shows, and the men who fought were called gladiators. These gladiators were generally prisoners taken in war or kidnapped in the provinces, and sometimes they were criminals. They were often trained for years. Not only men, but women and even children of every class, gazed in admiration at these fights, and saw without a scruple their fellow-men "butchered to make a Roman holiday."

Changes in the character of the Romans.

The country.



PERISTYLE OF THE QUÆSTOR'S HOUSE AT POMPEII.

The city.

The shows.

Gladiators.

These sights of blood and suffering brutalised the people and made them cruel and bloodthirsty, while the presents of food destroyed their independence. With the great body of electors thus brutalized and pauperized, it is not to be wondered at that the magistrates they elected were brutal and corrupt. The bribes a candidate had to buy his popularity with were enough to ruin him, and he could only retrieve his fortune by exacting bribes in turn from those who came under his power and whom he ought to have protected. A governorship of a province was the great prize by means of which a bankrupt but successful candidate could set himself up again. Away in his province he was a despot, with little to fear from the senate at Rome, to whom alone he was responsible, and from whom he could in case of need buy his acquittal.

Effect on the magistracy.

Another thing which had a great influence on Roman manners and ideas was the influence of the nations whom they conquered, and with whom they were thus brought into close contact. In this way Greek ideas exercised an immense influence. The Greeks were at this time far in advance of their Roman masters in literature, art, and science. The Roman nobles were not slow to perceive this, and, to their credit, they tried hard to acquire as much as possible of Greek culture. The language, literature, and art of Greece became the fashion, and were studied enthusiastically. Rome was full of Greek professors and philosophers. Perhaps the most important effect of this was that the nobles at first, and afterwards the

Influence of the conquered nations.

Greek ideas.

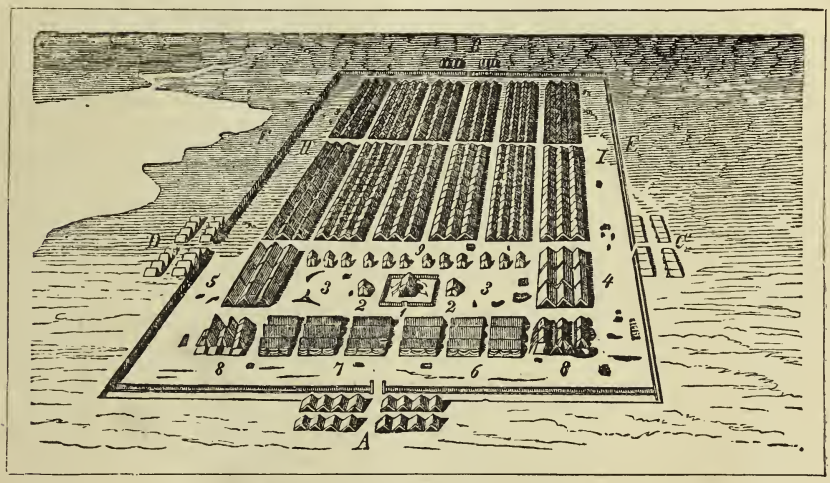
whole people, began to lose faith in their old gods, while they felt but little enthusiasm for the new importations from abroad ; and soon they began to think, as one of their poets put it, that "if there were gods at all they certainly did not trouble themselves about the affairs of men."

The most illustrious champion of these new ideas and manners was Scipio Africanus, the conqueror of Hannibal, and their ablest and most bitter opponent was Cato the censor. Scipio managed to make himself unpopular in spite of his superb services to the state, and went into voluntary exile. Cato tried hard to keep up the old state of things, and never ceased endeavouring by word and act to check the luxury and corruption which he saw gradually stealing over the people. His office as censor enabled him to punish and degrade unworthy nobles, and he exercised his

Scipio and Cato.

all through Italy. Where formerly there were smiling acres of corn land, tilled by prosperous peasants and resident gentry, now there were cattle farms or even wastes, looked after only by foreign slaves. Gentry and peasantry alike had vanished. Their lands had been confiscated by the senate and given to Roman nobles, who seldom visited their possessions, and cared only for the money they could make by their slave labour. Gracchus saw that things would go from bad to worse so long as the people of Rome itself, the seat of government and the source from which all authority was ultimately derived, was a rabble of lazy paupers, fed and amused by a few rich men who thus kept the government of the empire in their own hands. His plan was to make the citizens industrious and independent by giving them land to farm. He proposed to take for this purpose the public

Proposals of Gracchus.



PLAN OF A ROMAN MILITARY CAMP.

A, Decumanian gate ; B, Prætorian gate ; C and D, Principal side gates ; E, F, Via Quintana traversing the Camp ; I and II, Tents of the Legions. 1, The Prætorium ; 2, The Quæstorium ; 3, The Forum ; 4 and 5, Tents of Roman Volunteers ; 6 and 7, Tents of the Main Body and of Allies ; 8, Foreign Auxiliaries ; 9, Tents of the Twelve Military Tribunes.

power unsparingly. He set a noble example of simplicity in his own mode of life. But all his efforts could not stem the current, and in his old age he so far gave in to it himself that he took to studying Greek.

For a long time now the chief interest in Roman history lies in internal affairs, all important external enemies having been put down. Henceforth for many years a bitter struggle, breaking out every now and then into bloody civil wars and fearful massacres, was to occupy all the energies of public men. The first of these troubles was occasioned by the attempted reforms of the Gracchi. Tiberius Gracchus was a plebeian, although on his mother's side he was the grandson of the great patrician Scipio Africanus. He had seen how badly Italy and the provinces were governed, and was greatly impressed with the deserted, miserable look of the country parts

Internal affairs.

Tiberius Gracchus.

land, *i.e.* confiscated land which had been taken by the state from their Italian enemies. This land in theory belonged to the state and not to private individuals ; but the nobles had managed to get it "let" to themselves at a very low rent or none at all. After a time they began to look upon these lands as their own. The proposal to take it from these nobles and give it to poor citizens naturally roused the nobles, and they got one of Tiberius's fellow tribunes to oppose his proposal. As no law could be passed without the unanimous consent of all the tribunes, Gracchus could not get his reform carried out. But having set his heart on carrying his measure at all hazards, he managed to get the obstructive tribune illegally driven from office, and then his law was passed. But it did not produce much immediate effect beyond exasperating the nobles ; and in the riots which occurred at his second

Death of Tiberius Gracchus.

election to the tribuneship, he was killed, with three hundred of his party. This was the beginning of civil bloodshed in the streets of the city of Rome.

For the next ten years agitation and intrigue went on, and the nobles managed to prevent the land laws of Tiberius Gracchus from being carried out. But at last Caius Gracchus, the younger brother and colleague of Tiberius, was elected to the tribuneship, and for a time carried his reforms with a high hand. Without paying any regard to the senate, he proceeded to carry out laws passed by the people alone. He got a law passed by which the poor of Rome were to have a certain amount of corn regularly distributed among them gratuitously. He taxed articles of luxury. He supplied clothes freely to the soldiers. He gave public land to some of the poor, and created public works for others; and finally he ordered that jurymen should in future be selected from the knights instead of from the senate as heretofore. The knights were rich men who were not of noble birth and not in the senate. This was an important matter for the provinces, because the governors of the provinces were always senators, and if they were tried for their misdeeds before a jury of their own order they were sure to escape, but when tried by knights they were more likely to be convicted.

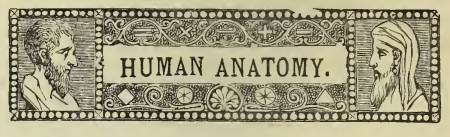
Caius Gracchus.

His agrarian laws.

But his next proposal, though perhaps the wisest and most statesmanlike of all his efforts, was distasteful to the people, and was rejected by them. This was a proposal to admit all Latins to the privileges of Roman citizens. You will recollect that only citizens of Rome had any share in the government of the empire, and this had now become so large and important that it was hardly possible for one town to rule it properly. Caius Gracchus wished to place the governing power of the empire on a wider basis by admitting other Italians to the franchise, and the Latins had very strong claims. They had always been faithful allies, and were, indeed, a branch of the same race. But the citizens of Rome had no wish to share their power and their cheap corn and free amusements with any one else. So next year they did not elect Caius Gracchus to the tribuneship. His power being thus gone and his person no longer inviolable, his patrician enemies were not long in getting rid of him. They managed to provoke a riot, in which he and a number of his friends were killed, B.C. 121. Thus fell Caius Gracchus, in the same cause and in much the same manner as his elder brother Tiberius. Their mother, Cornelia, when they were young boys, and some fine lady was boasting of her jewels, called them to her side and said, "These are my jewels." The people long remembered this saying, and in later years erected statues to the memory of the brothers. In after days the statue of Cornelia herself was set up in the Forum. It was cast in bronze, and beneath it was placed the simple inscription, "To Cornelia the mother of the Gracchi."

Attempt to widen the franchise.

Fall of C. Gracchus.



VII.

Changes from Youth to Old Age.

Development and Growth.

There are many things of great interest to be observed in the progress of the human frame through its various stages. A distinctive sign of the predominance of the mental faculties in man is to be found in the size of the skull or brain-case. This superiority is especially manifest in early life. Long before birth, in the second month of embryonic life, the head is already half the length of the whole creature. At birth the trunk has grown in relative length, and the head is only one-fourth of the total; while in the adult the head measures but one-eighth of the entire height of the body.

Size of the head.

Why, we may ask, should the infant who has scarcely yet commenced to think have a head so disproportionately large? Why should the relative size of the head decrease as the faculties become matured, the body strengthened, and the mind continually exercised? We shall learn hereafter that the brain is encased in a closely-fitted bony box, since it is essential that this delicate organ should be protected in the most perfect manner. It seems impossible to imagine a box which shall be always closely packed up, and yet shall be continually capable of growth. Consequently we find the skull large from the first, with contents much more soft and pulpy than in adult life. The skull becomes more solid and dense with age, as the brain becomes more firm and of improved quality.

Reason for infant's large head.

Very strangely, when the body is dwarfed or more or less deformed, the head is still disproportionately large, or even larger than in other persons. This shows that an unequal balance of growth has occurred. So also fast-growing persons, or those who are beyond the average height, frequently have small heads.

Large heads of dwarfs and deformed persons.

The early disproportion we have mentioned has to do especially with the brain-case; the face is comparatively small, and well packed under the brow. After birth the face grows more rapidly, especially during the times of teething. The jaws of a well-developed man are much larger and more massive in proportion than those of a child. If the general growth is stunted, the face also remains small, while the brain-case is large.

Relative size of brain-case and face.

During the period of youth the forehead usually becomes more prominent from changes in the underlying bones and the cavity of the brain. A prominent ridge, the super-

Head in childhood and old age.

ciliary,* is developed along the eyebrows, due to the growth of spaces or sinuses in the frontal bones beneath. The face also becomes lengthened by the growth of the parts belonging to the nose, as well as the development of the bony supports of the teeth. The upper jaw grows very much, and becomes more conspicuous, by the expansion of sinuses in the maxillary bones; the cheek-bones at the same time project further.

Loss of teeth.

In old age the face again becomes reduced by the falling out of the teeth and the dwindling of the jaws where the sockets of the teeth were. The upper jaw appears somewhat drawn back, the bone having actually diminished. The lower jaw cannot be similarly drawn back, because of its connection with the muscles; and it consequently is protruded forwards in front of the upper jaw. It has also to be raised into the position formerly occupied by the teeth, and thus the chin is made more prominent.

It may be mentioned that when a single tooth is drawn, the socket in which it was implanted becomes obliterated, thus altering the shape of the jaw. Those who lose many teeth put on the appearance of premature old age, in this feature at least.

Proportions of the limbs.

Two months before birth the arms and the legs are very nearly of equal length, and the division into upper arm, forearm, and hand, into thigh, leg, and foot, is quite perceptible. The nails are distinguishable on the fingers at this period. The arm and thigh are shorter than the hand and foot, contrary to the condition in adult life. Thus it will be seen that the human embryo has more nearly the proportions of the adult negro and of the man-like apes than of the adult white.

Dwarfs.

The interesting beings so frequently exhibited as dwarfs are mostly not really deformed, but have the same proportions as those of ordinary stature. We simply find the whole structure below the normal size. The skeleton of Nicholas Perry, aged twenty-three, the celebrated Polish dwarf, preserved in Paris in the museum of the Jardin des Plantes, is under three feet high, and the proportions of head, trunk, and limbs are quite good.

The dimensions of giants.

The proportions of trunk and limbs in giants offer more variety. In some the trunk is long, in others the legs contribute more to the height. Some show simply a general increase of all parts.

Skeleton of O'Byrne.

Professor Humphry measured the skeleton of O'Byrne, in the museum of the College of Surgeons. He died at twenty-two years of age, and his height was eight feet two inches. It was not found that his arms were above the normal proportion; in fact, they were rather below it. His great height was considerably due to his long leg and thigh-bones.

Difference between man and woman.

The whole frame of the woman is generally smaller than that of man. Yet the brain-case and the brain are larger in *proportion* to the body than in man. The limbs are shorter, the dimensions of the thigh, the foot, and the hand being more especially small. While the cross measurement of the chest is less, the distance between the hips is considerably greater in woman.

DIMENSIONS IN INCHES.

	Height.	Length of spine.	Arm-bone (Humerus)	Forearm bone (Radius).	Hand.	Thigh bone (Femur).	Leg-bone (Tibia).	Foot.
European (average of 25)	65	22·2	12·7	9·2	7·3	17·9	14·4	10·6
Orang (average of 2) . .	44	18	14	14	10	10·6	9·2	12
O'Byrne	98	30	17	13	10	24·2	21	12·5
Sicilian female aged 10, (College of Surgeons)	20	6·2	3·5	2·6	2·2	5	3·5	2·8

From the above table, compiled from Professor Humphry's valuable work on the human skeleton, it will be seen how different are the proportions in the orang and the European man. With a total height only two-thirds that of the man, the orang has a humerus longer than man's, and a radius very much longer. Man's superiority is shown in his greatly lengthened thigh and leg.

We gain an additional admiration for the bodily structure when we consider by what different means the brain-case is preserved from injury in youth and in riper years. How is it that the child endures with impunity blows that would be fatal to an aged person? We require to be protected not merely against the actual fracture of the skull by violence, but also against concussions or vibrations, which have more injurious effects upon the brain than many a hard blow.

Protection from injury to head.

In the child the brain-case is much thinner, more elastic and uniform in texture than at a later period; the brain also is of an altogether softer texture. The large bones at birth

* Superciliary, belonging to the eyebrows. Lat. *super* = above, and *cilia* = the eyelashes.

have not developed the *sutures*, or minute interlocking teeth, which unite them so firmly together subsequently. At some parts even they are not closely united at all, as at the spots known as the anterior and posterior fontanelles, at the junction of the frontal with the parietals, and of the parietals with the occipital bone.

Bones of child's skull.

Gradually, as the brain becomes firm and the brain-case enlarges, the sutures are completed, and the bones so strongly united that it would be a more difficult matter to separate them at the sutures than to break some of the individual bones.

Union in adult life.

Another change of great importance takes place Instead of the bones being of a nearly uniform texture in their thickness, the large bones become split into layers, an outer and an inner more dense, with a middle layer, the *diploë*,* composed of a meshwork of cells, a honeycomb, in fact, supported by

Formation of diploe.

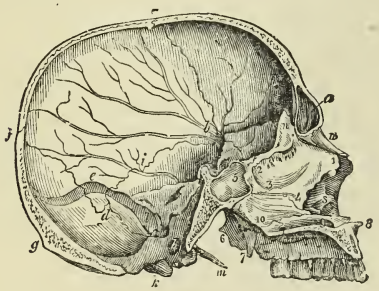


FIG. 15.—VERTICAL SECTION THROUGH THE SKULL A LITTLE TO THE LEFT OF THE MEDIAN LINE.

a, The frontal sinus; *b*, *c*, the coronal suture; *b*, *d*, *f*, *e*, the internal surface of the parietal bone and parietal fossa; *d*, *f*, the lambdoidal suture and superior occipital fossa; *b*, *i*, the ramified grooves which traverse the internal surface of the cranium,—they are partly for the transmission of arteries, partly for veins; *h*, the anterior condyloid foramen; *n*, the crista galli; *u*, the nasal bone; 5, the sphenoidal sinus; 8, the anterior nasal spine; *b*, *i*, *d*, the tempero-parietal suture, which becomes continuous with the lambdoidal suture; 3, the superior or sphenoidal border of the vomer; 3 4, the anterior ethmoidal border; *t* 10, the posterior or guttural edge; 1 4 8, the deep notch in the front of the nasal septum, which in the fresh state is occupied by cartilage; 9, palate process of superior maxilla; *l*, groove of the lateral sinus; *m*, styloid process; 6, external pterygoid process; 7, internal pterygoid process.

hard bony matter. Thus vibrations from outside are interrupted and deadened by the middle layer. This process is carried further in front, the frontal and maxillary and other bones developing large spaces, called *sinuses*, within them.

Another point of structure is worth mentioning. Our soft features are all in front, exposed to all dangers which arise in the struggle for existence or food. But our hands and arms work naturally in front, and defend our face. We

Strength of back of head.

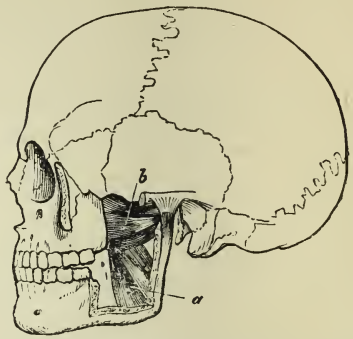


FIG. 16.—LATERAL VIEW OF THE SKULL, WITH A PORTION OF THE LOWER JAW REMOVED, SO AS TO DISPLAY THE PTERYGO-MAXILLARY REGION.

a, the internal pterygoid muscle;
b, the external pterygoid muscle.

have no corresponding protection for the back of the head, and we are liable to fall backwards. The occipital bone is, however, strengthened by transverse ridges and prominences, and is altogether very strong and capable of bearing much violence.

* *Diploë*, a Greek word meaning a doubling or folding.

XLIX.

SYNTAX.—THE INDICATIVE MOOD.

THE indicative mood is used either to state a proposition, and so used *predicatively*, or else to ask a question, and so used *interrogatively*.

A. The indicative mood used predicatively.

(1) The Present tense is often used for a *vast* tense in narrative for the sake of more vivid description, and it is for this reason called the *historical present;* as in *Dum hæc geruntur, Cassivelaunus nuntios mittit*, when these things are being carried on Cassivelaunus sends messengers.

(2) The Past Imperfect tense is often used of what was *wont to be done*—as in *Archytas nullam capitaliorem pestem quàm voluptatem corporis dicebat a natura datum*, Archytas used to say that no more fatal scourge had been brought upon men by the gods than carnal pleasure.

(3) The past imperfect tense is also used to signify that something was *attempted to be done*—as *Antiochus filiam suam in matrimonium mihi dabat*. Antiochus was for giving (wanted to give) me his daughter in marriage.

(4) The past imperfect tense is also used in

epistolary correspondence for that which is *present* at a time to *the writer*, but will appear as *past* to the reader—as in *Ita* ERANT *omnia, quæ isthine afferebantur incerta, ut quid ad te sciberem non occurreret*, all that was brought me from your locality is so uncertain that it does not occur to me what I should write to you.

(5) The Perfect tense is used after *postquam*, after that; *ut primum, simul ac, atque*, as soon as; *ut, ubi*, when, where in English we often use the past perfect—as in *Ut Hostius* CECIDIT, *confestim Romana inclinatum acie*, as soon as Hostius fell (in battle) immediately the Roman battle array gives way.

(6) The Past Perfect indicative is sometimes used by the poets for the past perfect subjunctive, for the sake of greater vividness, as in Horace's Odes :—

> "*Me truncus illapsus cerebro*
> SUSTULERAT, *nisi Faunus ictum*
> *Dextra levasset*"

(The trunk of a tree slipping on my brain had [would have] swept me off in death had not Faunus with his right hand lightened the blow.) This idiom reminds one of the use of the past-perfect when equivalent to a past tense indicative with ἄν in Greek.

(7) Occasionally the Future Perfect is used to indicate that a thing will be finished and done with immediately—as in *Dum loquimur*, FUGERIT *invida ætas*, while we are speaking envious time will have fled.

(8) Both the future perfect and the simple future are sometimes used in compound sentences where in English the sign of the future time is not given—as in *Naturam si* SEQUEMUR *ducem, nunquam aberrabimus*, if we follow nature as our guide, we shall never err.

B. The indicative mood used *interrogatively.*

(1) The indicative mood is used with interrogative pronouns and adverbs in asking *direct* questions—as in *Quousque tandem, Catilina, abutêre patientiâ nostrâ?* how long, I pray thee, O Catiline, wilt thou abuse this patience of ours?

(2) The indicative mood is used in asking double direct questions with the particles *utrum, an, ne;* but observe that *utrum* is used only in the first alternative, *an* only in the second, and *-ne* (appended to the word) is used in *both*—as in *Utrum ea vestra an nostra culpa est?* is that your fault or ours? Sometimes the first particle *utrum* is omitted—as in *Sunt hæc tua verba necne?* are these your words or not?

(3) The indicative mood is used when the interrogative particle *an* is used *apparently* in single questions, though really in a *double* question, the alternative being always *understood*—as in *Quid dices?* AN *bello fugitivorum Siciliam virtute tuâ liberatam?* what say you? or will you say that Sicily was by your wisdom delivered from the war of fugitive slaves?

Remember (1) that *num* and *numquid* always imply a negative answer—as *Num hæc fecit?* he did not do these things, did he?

(2) *Nonne* always implies an affirmative answer—as in *Nonne hæc fecit?* he did these things, did he not?

(3) The particle *ne* interrogative is always *enclitic*,—that is, it follows on to some other word, and never begins a sentence—as in *Tune rex eras?* is it you who were a king?

(4) The interrogative *num* always begins a sentence; but remember that *num* in *indirect* questions loses its *negative meaning.*

(5) The following is the order of sequence in the use of interrogative particles with alternatives :—

First alternative.	Second.	Third.
utrum	*an*	*an*
nĕ	*an*	*an*
understood	*an*	*an*
understood	*ne*	*an*

Translate into English :—

Num vis consul fieri? Num bellum pace melius est? Dimisso senatu, decemviri prodeunt in concionem, abdicantque se magistratu, ingenti hominum lætitiâ. Dum obsequor adolescentibus, me senem esse sum oblitus. Nisi properè fit quod impero, vinciri vos jam jubeo. Rege amisso rupere fidem constructaque multa deripuere. Noctes vigilabat ad ipsum mane, diem totum stertebat. Qui Antonium oppressit eum in bello confecerit. Si pergis, abiero. Quid inventum sit, paulò post videro. Dum hæc parantur, Saguntum jam oppugnabatur. Ut Romæ consules, sic Carthagine quotannis annui bini reges creabantur. Cato pro lege quæ abrogabatur ita disseruit. Pelopidas non dubitavit, simul ac conspexit hostem, confligere. Nihil tum habebam quod sciberem, neque enim quicquam novi audieram. Hoc, dum erimus in terris, erit cœlesti vitæ simile. De Carthagine vereri non antè desinam, quàm illam excisam esse cognovero. Ut valet? Ut meminet nostri. Tarquinius rex interrogavit, Estisne vos legati oratoresque missi a populo Collatino? Num hoc negare audes? Isne est quem quæro, annon? Quid ais? An Pamphilus venit? Ut verò sementem feceris, ita metis. Estne Deus, qui sentit, qui regit, et moderatur? Postquam lux certior erat, et Romani, qui cædibus superfuerant, in arcem confugerant, conticescebat qui tumultu, tum Tarentinos convocari jubet. Incertum est utrum abeant an maneant inter nostros acerrimos inimicos et hostes hujus reipublicæ.

Translate into Latin :—

I doubt whether you ought (*oporteat te*) to do these things or not unbidden (*injussus*). The last day is come to this greatest of cities. I used to walk on account of my health daily. Did you have nothing to write back? (Put this sentence in the *epistolary style* with the expected answer *no.*) I used often to think of you when I was staying in the country. Is it easier to die with glory or to live with disgrace? I have for a long time seen (*jamdudum video*) that it is our duty to go forth from our home at once and together to fight for our country, or else to kill ourselves with our own swords. What do you say? Has the army arrived in the city? Was this your fault or the fault of the slave who brought back the message (*hoc renuntiavit*)? Have you two

countries? or is one and the same country common to you and all your fellow-citizens? Pamphilis is not sorry (use *non piget*) for what he has done to me and to you and to other friends of ours.

Self-Examination Questions.

When is the indicative mood used *predicatively*, and when *interrogatively*? Give the occasional usage of the following tenses in the indicative mood when used predicatively: the present, past imperfect, the future, the perfect, the past perfect, and the future perfect. What is the usage of tenses in epistolary correspondence? Give examples. Mention any usages of tenses which are poetical. In what two ways is the indicative mood used interrogatively? What particles imply a negative and what an affirmative answer? What is peculiar about the position of *ne* and *num*? and also concerning the usage of *an*? Give a table showing the sequence of the interrogative particles in alternative sentences.

XLII.

THE VERB (*continued*).—THEORY.

I. THE VARIOUS CLASSES OF VERBS (*continued*).—The pronominal or reflective verbs are divided into three classes :—

a. Strictly reflective, or those in which the verb never appears apart from the reflective pronoun : such are *s'abstenir*, to abstain ; *s'accouder*, to lean on one's elbow ; *s'agenouiller*, to kneel ; *s'emparer*, to seize upon ; *s'enfuir*, to run away ; *se repentir*, to repent ; *se souvenir*, to remember, etc.

b. Accidentally reflective, or those which, in another acceptation, may appear without the reflective pronoun : such are *se promener*, to take a walk ; *se prendre*, to be taken ; *se venger*, to avenge oneself ; *s'anéantir*, to perish ; *s'endormir*, to fall asleep, etc. For one says, without using the reflective pronoun, *je promène mon chien*, I give an airing to my dog ; *vous endormirez le petit*, you will lull baby to sleep, etc.

c. Reciprocal, or those which imply that two agents at least react on each other : *s'entr' aimer*, to love one another ; *se partager*, to divide among ; *se contrecarrer*, to thwart one another ; *s'entr'égorger*, to cut each other's throat ; *s'entr'aider*, to help one another, etc. In simply passing from the singular to the plural a verb may become reciprocal : *cet individu se comprend*, that individual understands his own meaning ; *ces deux individus se comprennent comme larrons en foire*, those two individuals understand each other, or are agreed.

Whether a verb be strictly or accidentally reflective or reciprocal, there is no difference in the conjugation, which, in the single tenses, is done in strict accordance with the models for the four conjugations. The compound tenses take *être*, which there appears with the force of *avoir* ; for when we say *je me suis consolé*, this can mean nothing else but *j'ai consolé moi*. Therefore the past participle of such verbs agrees, like all participles conjugated with *avoir*, with the direct object placed before the verb, and not otherwise. *Nous nous* sommes *blessés*, meaning *nous nous* avons *blessés* ; we see that *blessés* must agree with the second *nous*, which is the direct object of the verb.

The past participle of a strictly reflective verb always agrees with the reflective pronoun, as this happens to be its direct object : *la femme s'est abstenue ; les filles s'étaient accoudées ; les pêcheurs se sont repentis*, etc. The only exception is *s'arroger*, to assume to oneself, which does not govern the direct object of the person, but otherwise follows the general rule of agreement : *cette nation s'est arrogé des droits*, that nation has assumed rights : the direct object *des droits* comes after ; but there is agreement in *les droits que cette nation s'est arrogés*, because the direct object *que* (m. pl. standing for its antecedent *droits*) precedes.

The past participle of all other reflective verbs will generally agree with the reflective pronoun when the reflective is derived from a transitive verb, and remain invariable when the reflective is derived from an intransitive verb. We should write *comment s'est anéantie tant de gloire*, making *anéantie* agree with *s'*, f. s., as this verb comes from active transitive *anéantir*, to destroy ; but leave the past participle untouched in the following, *nous nous sommes parlé*, this verb coming from the intransitive *parler*. Nothing but a thorough knowledge of the government of verbs will avail here ; and when that is acquired the sense of each particular phrase demands yet to be considered. Suppose we know thoroughly the nature of *rendre*, to return, we must yet distinguish between *ils se sont rendus à nos conseils* and *ils se sont rendu des services ;* the first means they have surrendered *themselves* to our advice ; the second, they have rendered services *to each other :* in the first *se* is a direct object with which *rendu* agrees, since it precedes it ; in the second, *se* is an indirect object, and *rendu* does not change, as its direct object (*des services*) follows.

When the two languages are compared, it is found that pronominal verbs abound in French, where they seem to assume the importance which the passive possess in English. It will also be found that they convey four kinds of ideas : reflected action, as *je me console*, I console myself ; reciprocity, as *nous nous entr'aidons*, we help one another ; state, as *tu t'ébats*, thou makest merry, *la chandelle se meurt*, the candle is dying out ; passiveness, as *cela se fait mais cela ne se dit pas*, that is done but it is not spoken of.

French reciprocal verbs may always be easily detected ; most of them are compounded of *entre*, inter, or they are followed by *l'un l'autre*, one another (*l'une l'autre, les uns les autres, les unes les autres*), which can leave no doubt on the mind. As to those pronominal

verbs which express reflected action or state, the discrimination is not always so easy We append a list of such verbs, which do not assume the reflective form in English :—

s'abstenir, *to abstain*
s'accouder, *to lean upon one's elbow*
s'accroupir, *to squat*
s'acharner, *to stick doggedly to*
s'acheminer, *to wend one's way*
s'agenouiller, *to kneel*
*s'*apercevoir,* *to notice*
s'arrêter, *to stop*
s'arroger, *to assume* [*doze*
*s'*assoupir, *to fall into a*
*s'*attendre à, *to expect*
s'attrouper, *to flock together*
*s'*aviser de, *to hit upon*
se baigner, *to bathe*
se blottir, *to crouch*
se cabrer, *to rear, to fire up*
se carrer, *to strut*
se comporter, *to behave*
se confesser, *to attend confession*
se dédire, *to retract*
se défier de, *to distrust*
se demander, *to wonder*
se démener, *to struggle*
se disputer, *to wrangle*
se douter de, *to guess*
s'ébahir, *to be astounded*
s'ébouler, *to give away, to*
s'échapper, *to escape* [*slip*
*s'*écouler, *to elapse*
s'écrier, *to exclaim*
s'écrouler, *to crumble down*
s'embusquer, *to lie in wait*
s'emparer, *to seize upon*
s'empresser, *to show eagerness*
s'en aller, *to go away*
*s'*encanailler, *to keep low company*
s'endormir, *to fall asleep*
s'enfuir, *to run away*
s'enquérir, *to inquire*
s'en retourner, *to return*
s'ensuivre, *to follow*
*s'*épouvanter, *to take fright*
s'escrimer, *to fence*
*s'*éteindre, *to go out*
*s'*étonner, *to wonder at*
s'évader, *to escape*
s'évanouir, *to swoon, to vanish*
s'évaporer, *to evaporate*
*s'*éveiller, *to awaken*
s'évertuer, *to make efforts*
s'extasier, *to be enraptured*
se faner, *to fade*
se fier, *to trust*
se formaliser, *to take offence*
se gargariser, *to gargle*
s'immiscer, *to interfere*
s'ingénier, *to try to hit upon a plan*
s'ingérer, *to meddle with*
se lasser, *to grow tired*
se lever, *to rise*
se louer de,† *to be pleased with*
se méfier de, *to distrust*
se méprendre, *to mistake*
se mettre à, *to begin*
se moquer de, *to laugh at*
se noyer,‡ *to get drowned*
s'obstiner, *to grow obstinate*
s'opiniâtrer, *to persist*
se passer de, *to dispense with*
se promener, *to walk*
se prévaloir, *to take advantage of*
se ratatiner, *to shrink*
se raviser, *to change one's mind*
se rebeller, *to revolt*
se récrier, *to cry out against, or express rapture*
se refrogner, *to frown*
se refroidir, *to grow cold*
se réfugier, *to take refuge*
se rengorger, *to draw oneself up*
se repentir, *to repent*
se ressouvenir, *to recollect*
se réveiller, *to awaken*
se rire de, *to mock*
se rouiller, *to get rusty*
se souvenir, *to remember*
se taire, *to keep silent*
se tenir debout, *to stand*

We subjoin a list of pronominal verbs expressing passiveness, and rendered by the English passive (*see* last lesson).

s'acheter, *to be bought*
s'acquérir, *to be acquired*
s'anéantir, *to be annihilated*
s'appeler, *to be called*
se célébrer, *to be held*
se compter, *to be reckoned*
se conjuguer, *to be conjugated*
se conserver, *to be kept*
se dire, *to be said*
s'écrire, *to be written*
s'entendre, *to be heard*
se faire, *to be done*
se guérir, *to be cured*
se manger, *to be eaten*
s'obtenir, *to be obtained*
se pardonner, *to be forgiven*
se parler, *to be spoken*
se prendre, *to be taken*
se servir, *to be served*
se trouver, *to be found*
se vendre, *to be sold*
se voir, *to be seen*

Remark.—The verbs in the above list, which might be much extended, are, with the exception of two or three, used in the 3rd person (sing. and plur.) only.

* When the reflective pronoun appears in italics it precedes an accidentally reflective verb; the other verbs being strictly reflective.

† Has other three meanings: to praise oneself, to praise one another, to be let.

‡ Means also to drown oneself.

II. Comparative Study of the Possessive Adjective.

a. Idiomatic phrases in which English has the possessive and French has not.

1. *On our way home*, en revenant chez nous; *on our return home*, en arrivant chez nous.
2. *I change my coat*, je change d'habit; *thou changest thy shirt*, tu changes de chemise; *he changes his master*, il change de maître; *we change our religion*, nous changeons de religion; *you change your mind*, vous changez d'avis, *they change their determination*, ils changent de résolution.
3. *To be in people's way*, gêner; *you are not in my way*, vous ne me gênez pas; *is this in your way?* ceci vous gêne-t-il?
4. *To dress one's hair*, se coiffer; *go and dress your hair*, allez vous coiffer. *To put on one's boots*, se chausser; *they are putting on their boots*, ils se chaussent. *To put on one's gloves*, se ganter; *she put her gloves hastily on*, elle se ganta à la hâte. *To put on one's hat*, se couvrir; *do put on your hat*, couvrez-vous donc (*also* mettez).
5. *To take one's hair down*, se décoiffer; *to take one's clothes off*, se déshabiller; *to take one's boots off*, se déchausser; *to take one's gloves off*, se déganter; *to take one's hat off*, se découvrir.
6. *To make one's first appearance*, débuter; *she made her first appearance at Brussels*, elle débuta (*but also* elle fit ses débuts) à Bruxelles.
7. *To make up people's own material*, travailler à façon; *this dressmaker makes up ladies' own materials*, cette couturière fait les robes à façon.
8. *To make people's clothes for them*, habiller; *who makes your clothes?* qui vous habille?
9. *On my, thy, his, her account*, à cause de moi, de toi, de lui, d'elle; *with reference to us, to you, to them*, par rapport à nous, à vous, à eux (*or* à elles).
10. *You exhaust his patience*, vous le poussez à bout (*but say also* vous épuisez sa patience).
11. *To be confined to one's bed*, garder le lit; *he is confined to his bed, to his room*, il garde le lit, la chambre.
12. *Ask for my character*, allez aux informations sur moi (*but also* sur mon compte).
13. *To the best of our belief*, autant que nous pouvons le croire, *or* à ce que nous croyons.
14. *One's flesh creeps at it*, on en a de la chair de poule; *he makes our flesh creep*, il nous donne la chair de poule.
15. *It is my good fortune to*, j'ai le bonheur de; *it is my sad privilege to*, j'ai le triste privilège de.
16. *Whatever lies in my power*, tout ce qui dépend de moi; *he will do everything that lies in his power*, il fera tout ce qui dépend de lui.
17. *I beg your pardon*, je vous demande pardon; *our pardon was asked*, on nous demanda pardon.
18. *It is your turn to pay*, c'est à vous à payer; *it is your duty to pay*, c'est à vous de payer.
19. *It will be worth your while to think of it*, il vaudra la peine que vous y songiez.
20. *To live by one's wits*, être un chevalier d'industrie; *I need not know your grievance against L. to realise that he is a man who lives by his wits*, je n'ai pas besoin de connaître votre grief contre L., pour savoir que c'est un vrai chevalier d'industrie (Ch. de Bernard).—*To be at one's wits' end*, ne savoir de quel bois faire flèche, *or* ne savoir à quel saint se vouer, *or* être au bout de son latin.—*He was frightened out of his wits*, il perdit la tête.

b. A case where the possessive of one person is rendered by that of another :—

I shall give you a piece of my mind, je vous dirai votre fait; *we will give her a piece of our mind*, nous lui dirons ses vérités.

c. Idiomatic phrases in which French has the possessive adjective and English not.

1. A mon insu, *unknown to me;* à leur insu, *unknown to them* (à l'insu de la mère = *unknown to the mother*).
2. Vous recevrez de nos nouvelles, *you will hear from us;* vous nous donnerez de vos nouvelles, *you will let us hear from you* (nous en avons des nouvelles = *we have heard from him, her, it, them*).
3. Il vint à notre rencontre, *he came to meet us;* nous allâmes à leur rencontre, *we went to meet them;* vous êtes venu à ma rencontre comme j'allais me rendre à la vôtre, *you came to meet me just as I was going to meet you.*
4. A mon égard, *to[illegible]rds me;* à ton égard, *towards thee.*

5. Etre bien dans ses affaires, *to be in good circumstances;* elle est bien mal dans ses affaires, *she is very badly off.*
6. Le marchand de bestiaux a du foin dans ses bottes, *the cattle-dealer has saved money* (dans les bottes would mean *he has hay in his top-boots*).
7. Le percement du tunnel de la Manche amènera beaucoup de difficultés à sa suite, *the piercing of the Channel tunnel will be attended with many difficulties.*
8. Mourir de sa belle mort, *to die a natural death.*
9. En faire à sa tête, *to do as one chooses;* j'en veux faire à ma tête et non à la vôtre, *I want to do as I like, and not as you like.*
10. Manger son blé en herbe, *to eat the chicken in the egg.*
11. Comme la conférence tirait vers sa fin, *as the conference was drawing to an end.*
12. Il tomba de son long, *he fell full length;* elle tomba de son haut, *she was amazed.*
13. Se mettre sur son séant, *to sit up, recovering from a recumbent position.*
14. Payer de sa personne, *not to spare oneself.*
15. Faire son chemin dans le monde, *to get on in the world;* il fit son chemin au barreau, *he got on at the bar.*
16. Le chancelier d'Agueseau aimait beaucoup les anciens poètes: leur lecture fut une passion de sa jeunesse, *Chancellor d'Agueseau was very fond of the old poets: the reading of them was a passion of his youth.*
17. Votre énigme est trop difficile, je jette ma langue aux chiens (Acad.), *your riddle is too hard, I give it up.*
18. Prenez garde, je pourrais bien vous rendre la monnaie de votre pièce, *take care, I might feel inclined to return you tit for tat.*
19. Faire son droit, faire ses humanités, *to study the law, humanities;* mon neveu fait son droit à Paris; c'est là que j'ai fait le mien, *my nephew is studying law in Paris: it is there I, too, studied it.*
20. Cette maison est mon affaire, *this house suits me;* cela ferait bien mon affaire, *that would be just the thing for me;* son affaire est bonne, *he will catch it.*

[And as many again: il est maçon de son métier; layetier-emballeur de son état—avoir son franc-parler—servir un plat de son métier—retirers on épingle du jeu—faire ses excuses—voilà mon fait—parler à son aise, à son gré, etc.]

IV.

Hydraulic Machinery (*continued*).

Hydraulic apparatus of the description mentioned in our last article, has one great practical advantage—namely, that the elevated reservoir is a storehouse of energy. If, for instance, there were certain dock gates that had to be opened and closed once or twice a day, and if the operation required the combined efforts of twelve men for half an hour, it would be possible for one man to do the work in six hours of labour, if his six hours' work were accumulated, and then concentrated into a single half-hour. This result might be obtained by causing the man to pump water into an elevated reservoir during his six hours, then allowing the water by its pressure to work a suitable hydraulic engine, regulating the descent of the water so that it might be exhausted in half an hour. Thus, instead of having to keep twelve men idling eleven hours out of twelve, one man only at constant work would be necessary. The same principle may be applied to steam power when the work required is very heavy but only occasional. Instead of having to provide a steam engine that shall be equal to any emergency by its unaided exertions, a much smaller one, that would be quite useless alone, will furnish all the necessary power if kept constantly at work in connection with suitable hydraulic apparatus.

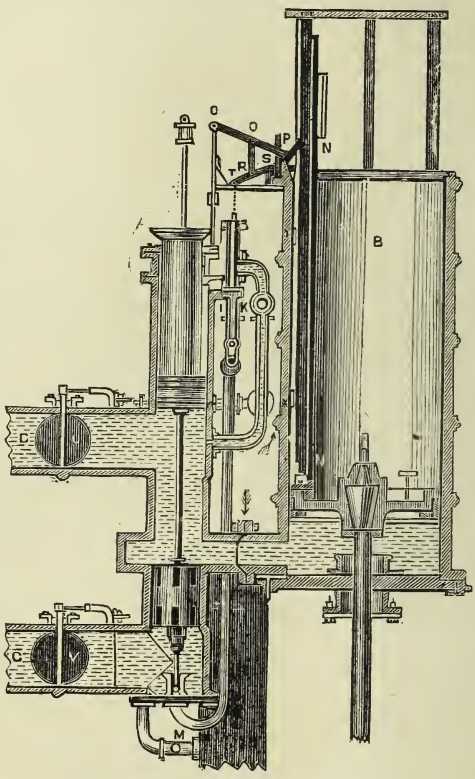


FIG. 14.

Water-pressure engines are used for converting this stored energy into active power. In general principles they may be compared with the steam engine, the water-pressure being made to work a piston from end to end of a cylinder. They are either single or double acting, according to whether the water pressure acts on one side only or on both sides of the piston. Fig 14 is a representation of a single-acting water-pressure engine, suitable for pumping in mines.

The water from an elevated reservoir enters the engine by the pipe marked C, passes the throttle-valve U, by which its flow is regulated, along D into the cylinder B, and by its pressure forces up the piston A. The piston-rod passes downwards through the lower end of the cylinder, that it may be conveniently attached to the pumping apparatus. When the piston approaches the top of the cylinder, a projection marked X on the rod NXY attached to the piston pushes the crutch P upwards, and so by means of the levers O, Q, T, R, S, moves the valve K

and allows the water to escape from the upper part of the auxiliary cylinder, so that the water pressure may force its piston upwards, together with the *piston-valve* E. When the piston-valve is above D, the water from the lower part of the main cylinder is free to escape through G, past the throttle-valve V, and the piston descends by its own weight added to the weight of the apparatus that is suspended to it. On its descent the projection Y pulls down the crutch P and so causes the piston-valve E to resume the position shown in the figure, that the main piston may be again raised by the water pressure. It will be observed that the piston-valve plays a similar part to the slide-valve of the steam engine.

Another important application of hydraulic power is seen in the *hydraulic press*, which will be described in the article on Pressing Machinery. The *hydraulic hoist* is merely a modification of the press.

Air and Gas Engines.

The great number of steam engines to be seen on every hand where power is required is too apt to impress one with the idea that steam is altogether peculiar in the readiness with which it lends itself for the conversion of heat into available power. Steam is water in the gaseous condition: why, then, can we not avail ourselves of the inexhaustible store of gaseous material that exists in the atmosphere, and so save the heat necessary to convert water into a gas? A practical answer to this question has been sought, and with a certain amount of success, but the machines that have been constructed have not been able to compete with the steam engine in economy.

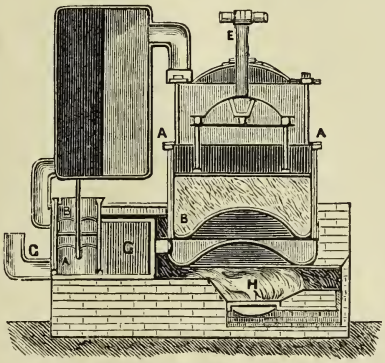


FIG. 15.

In replacing steam by a ready-made gas such as air, we do away with the necessity for a boiler, but we also lose the *pushing-force* developed in the boiler by the conversion of a comparatively small bulk of water into a great bulk of steam, and have instead only the force due to the expansion of the air when heated. Now, a given bulk of boiling water will furnish more than 1600 times its own bulk of steam without any rise in temperature; but a given quantity of air, if heated to a red heat, would be increased to only about three times its original bulk. These facts help to account for the great difference in size of the cylinders of steam and air engines, and for the failure of Ericsson's air engine to propel an ordinary steamboat of 1900 tons burden, although it was fitted with four cylinders each fourteen feet in diameter.

In air engines the heat is brought to bear directly upon the cylinder, and the loss of heat that must of necessity be incurred by its transference from one part to another of the machine is thus reduced to a minimum. When theoretically considered from this point of view, they compare very favourably with steam engines, for although the use of a separate boiler, distinct from the cylinder, was a great step in advance in the development of the steam engine, its introduction was prejudicial in so far as it increased the distance between the source of heat and the cylinder.

As an example of air engines in which a fresh quantity of air is employed for each stroke of the piston, we may refer to the original Ericsson air engine, a section of the principal parts of which is given in fig. 15.

Here B is the working cylinder heated by the furnace H, and A is the piston, which is hollow and filled with brickdust or other badly conducting substance, that the heat may be kept as far as possible below the piston. On the cylinder-cover stands another cylinder, D, with its piston C, which is connected with the piston A by means of three or four rods, *d*, *d*. The spaces in the two cylinders between the two pistons—that is, the upper part of B and the lower part of D—are open to the air by the holes *a*. *a*. E is the piston rod by which the motion is conveyed to the crank of the engine. The upper cylinder compresses the air, drawing it in at the valve *c* as its piston descends, and forcing it into the chamber F through the valve *e*. When the main piston A begins its upward motion it draws a charge of compressed air from the chamber F through *b* and G into the lower part of B; the valve *b* is then closed, the heat of the furnace expands the air and so forces the piston upwards; as it descends the valve *f* opens and allows the hot air to pass through G and the exhaust *g*, and so to escape. The chamber marked G is a most important part of the apparatus, the *regenerator*; it is filled with fine wire netting, which takes up a considerable portion of the heat of the hot air as it escapes from B, and raises the temperature of the next charge from F as it passes through. The heat that is so caught and returned to the cylinder means of course an equivalent amount of fuel saved.

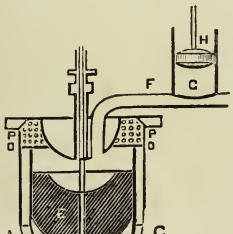


FIG. 16.

The air engine invented by Messrs. Stirling works with a certain quantity of air which is not renewed at each stroke, but is only gradually added to as may be necessary to compensate for leakage. Fig. 16 shows the principle of its action. The vessel A B C has a lining within it perforated at the bottom, and the

space between it and the cylinder from A to C is packed with strips of metal or glass to serve the purpose of a regenerator. D represents coils of copper pipe through which cold water is pumped, to keep the upper part of C A B cool. The plunger E works up and down, but is not fitted air-tight into the inner receiver or lining. Now, it is obvious that C A B contains a certain definite quantity of air, and that by the motion of E this air is transferred to the top or the bottom of the receiver. But if the bottom of the receiver is kept hot and the upper part cold, this bulk of air will be heated when it is below and cooled when it is above the plunger E, and so will alternately increase and decrease in volume, and alternately drive upwards and allow to descend the piston H working in the cylinder G. The regenerator which fills the annular space C A has exactly the same effect as in the previous example, but is even more useful and indeed necessary to facilitate the desired alterations in temperature of the air that passes through it.

Ericsson's "caloric engine," as now made, is similar in principle to Stirling's, but has one long cylinder in which both pistons work, the lower part of which is heated, and the upper part kept cool by a constant flow of water through a jacket that surrounds it. It is especially adapted for pumping on the small scale, and is constructed so as to pass the water raised through the jacket surrounding the upper part of the cylinder. The regenerator appears to be dispensed with.

Thus air engines, although they possess many theoretical advantages over steam engines, have so many drawbacks, that unless they can be radically improved, it is not likely that they will ever stand as rivals to the steam engine; except perhaps in special cases, as that referred to in the previous paragraph. But with gas engines the case is altogether different. The recent improvements that have been effected in them have rendered them so convenient, economical, and certain in action, that the demand for them is daily increasing.

In steam engines the fuel is burned outside the boiler, and the pressure so produced is conveyed to the more or less distant cylinder; in air engines the cylinder itself is heated by the direct action of the fuel; while in gas engines the fuel is introduced into the cylinder itself, so that the energy developed by the combustion is brought to bear *directly* upon that part of the apparatus that makes the energy available for general use.

The principle of action of all gas engines lies in the fact that coal gas when exploded with air produces a greater volume of gases than the original mixture, and that the heat generated by the explosion very considerably expands the resultant gases. The force of a gas explosion is perfectly familiar to all by report if not experience, and it is simply the development of this force under the piston of a cylinder that furnishes the power in gas engines. The heat produced by the repeated explosions passes to the mass of the cylinder, and would in time raise its temperature to a dangerous degree if it were not kept cool by surrounding at least the lower part of it by cold water. The cooling of the gases and their consequent condensation is assisted in Hugon's gas engine by injecting a small jet of water in the form of spray into the cylinder during each return stroke.

In Lenoir's engines the mixture of gas and air is exploded by passing an electric spark through it, but in the more modern makes a small flame that is kept continually burning ignites the mixture by actual contact. In Otto and Langen's engine the direct force of the explosion is not used, the piston being allowed to rush unimpeded to the top of the cylinder; the return stroke, which is accomplished by the atmospheric pressure aided by the weight of the piston and its connections, serves to give the required motion.

Probably the greatest improvement that has been effected in gas engines is the use of a compressed mixture of gas and air, for there seems little doubt that the wonderfully increased efficiency of the more modern engines is chiefly due to this change. The Otto and Clerk's gas engines convert into useful work about 18 per cent. of the total heat generated, while the Hugon engine loses all except some 4 per cent.

It will facilitate the appreciation of these figures if we compare them with the results yielded by ordinary steam engines. According to Sir Wm. Armstrong, the best of steam engines give about 10 per cent. of the whole heat energy as useful work, while the smaller portable ones probably give little more than 3 per cent. But if we take the calculated theoretical efficiencies we find a still greater difference, the steam engine yielding about 20 per cent. and the gas engine from 50 to 70 per per cent. of the heat produced.

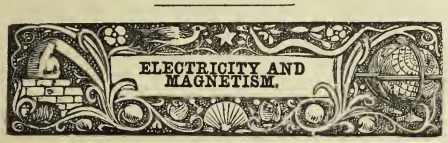
In an actual experiment it has been found that an Otto gas engine did the same amount of work with the gas from thirty-nine tons of coal, that an ordinary steam engine required the combustion of 217 tons to perform; thus showing a saving of 88 per cent. in the weight of fuel. The gas in this experiment was made by Dowson's producer.

The gas engine is still in its infancy, but when we consider what it has already done so far as economy is concerned, and the wide field that still remains open for it in this direction, besides the great convenience of being able to start or stop it at a moment's notice, it cannot be doubted but that it is destined to play a great part in the prime motors of the future.

On the subject of early experiments in gas engines we may add a few words. "The first gas engines," says a writer in *Knight's American Mechanical Dictionary*, "were gunpowder engines, the gas generated by the explosion being the means of expelling the air, the condensation of the gases producing a partial vacuum in the chamber. D'Hautefeuille, in 1678, seems to have been the first to use this power: Hugyhens applied it in a cylinder, so that the atmospheric pressure might force a piston downward when the vacuum was thus formed beneath it. Papin substituted a bell-

valve over the air-eduction port for the collapsible leathern tubes of Hugyhens.

"In 1791 Barber took an English patent for a gas engine, in which a stream of carburetted hydrogen gas was introduced at one induction port and a quantity of atmospheric air at another, the resulting combination giving an explosive force against the piston. Street, in 1794, proposed to use the expansive power of heated gas instead of its explosive power. Lebon's French patent of 1799 described the distillation of carburetted hydrogen from coal and its introduction into the cylinder beneath the piston, and simultaneously at another channel a proper proportion of atmospheric air. The mixed gases were then exploded by the electric spark, their dilatation furnishing the required motive power. The engine was self-regulating, and operated two pumps, one of them designed to introduce the supply of gas and the other that of air."



XXIII.

Voltaic Electricity (*continued*).

A modification of the ordinary galvanometer is sometimes used for determining the difference in intensity between any two currents, and is known as the *differential galvanometer*.

The differential galvanometer.

In this case two precisely similar wires are coiled round the wooden frame, and are carefully insulated from each other, and their ends connected with binding-screws, so that separate currents can be simultaneously passed through both coils, but in opposite directions. If the currents are of the same intensity no deflection of the needle takes place, but if the needle be deflected the direction of its deflection indicates the stronger current.

Although the ordinary astatic galvanometer is not available for measuring the absolute or relative intensities of currents, two instruments, known respectively as the *tangent compass* and the *sine compass* may be successfully employed for that purpose.

The tangent compass.

To those of our readers who may not have studied trigonometry the terms *sine* and *tangent* will prove unintelligible; we shall therefore make no apology for giving a very brief explanation of them.

Explanation of trigonometrical terms.

If, as in our diagram, fig. 80, we have an angle A formed by the two lines A P, A M, and if we draw a line P M *anywhere* on A M and perpendicular to it, so long as the angle A remains unchanged there will always be a definite, unchanging ratio or proportion between the three lines A P, A M, P M. To these ratios between the lines the term *Trigonometrical Ratios* has been applied, and to each ratio a special name has been given. For instance, the fraction produced by dividing the perpendicular P M by the hypothenuse A P is termed

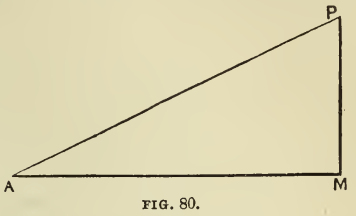


FIG. 80.

the *sine* of the angle A, and is usually expressed thus :—$\frac{P\,M}{A\,P}$ = *sin* A. In the same manner the perpendicular P M divided by the base A M is known as the *tangent* of the angle A, and is usually expressed by the following formula :—$\frac{P\,M}{A\,M}$ = *tan* A. In the same manner each of the other ratios between the three lines of the triangle has a name, but as we are only concerned to know the meaning of the terms *sine* and *tangent* we will not pursue the subject further.

All these ratios have been calculated for every possible angle, and a table of their values will be found in every book of logarithms.

Having now some idea of the meaning of the term "tangent of an angle" we will proceed to describe the *tangent compass*, or as it is more frequently termed, the *tangent galvanometer*. It is found that when a magnetic needle is suspended in the plane of the magnetic meridian, and a current caused to flow round it, the intensity of the current is directly proportional to the tangent of the angle of deflection. This fact is, however, strictly true only when the needle is very small as compared with the diameter of the circuit.

The tangent galvanometer.

Accordingly the tangent galvanometer consists, as shown in fig. 81, of a ring of copper, usually some twelve inches in diameter, which is fixed in a vertical position upon a stand, the lower half of the ring being generally fixed, to secure its steadiness, in a wooden frame. In the centre a small magnetic needle, not more than a tenth of the diameter of the copper ring in length, is suspended. Beneath this needle is a graduated circle. To the ends of the copper ring wires are attached, which are led into the mercury cups, *a*, *b*, and a battery can be easily connected with the galvanometer by plunging its wires into the mercury. When used the circle is placed in the magnetic meridian and the angle to which the needle is deflected is read off. It must, however, be remembered that it is not this angle, *but its tangent*, which indicates the intensity of the current; the value of the latter must therefore be obtained from a table of tangents.

The *sine compass*, or *sine galvanometer*, represented in fig. 82, is used for measuring strong voltaic currents. It consists of a circular frame, M, round which several turns of stout covered copper wire are coiled, their ends

The sine galvanometer.

terminating in binding-screws at E. In the centre of the ring is fixed a circular platform, and in the centre of this platform a magnetic needle, *m*, is suspended. Round the edge of the platform is a graduated circle, N, and a light pointer, *n*, is attached to the magnetic needle, so that it can move along the circle N when the needle is deflected. The circle M, and with it the circular platform N, is supported on a foot, O, which is movable about a vertical axis passing through the centre of the fixed horizontal circle H.

In using the instrument, M is placed in the magnetic meridian, and wires, *a b*, from the battery being attached to the binding-screws at E, the current is allowed to pass. The needle being deflected, the ring M is turned until it coincides with the vertical plane passing through the magnetic needle *m*. The directive action of the current is now exerted perpendicularly to the direction of the magnetic needle, and it can be proved that the intensity of the current is proportional to the sine of the angle of deflection. The angle itself is measured on the graduated circle H, by means of a vernier attached to the piece C, and the value of its sine may be obtained, as in the case of the tangent, from the tables.

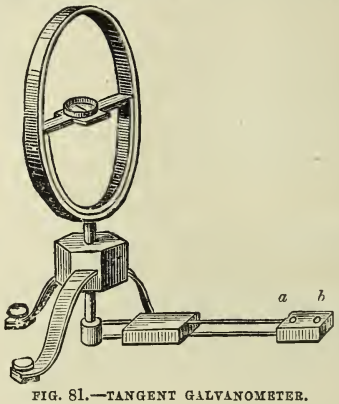


FIG. 81.—TANGENT GALVANOMETER.

Besides these instruments for measuring the intensity of a voltaic current, we must not omit to mention the *voltameter*, due to Faraday, which depends for its action upon the electrolytic action of the current upon water.

The voltameter.

This consists of a glass vessel in which two platinum electrodes are fixed. In the neck of this vessel a bent tube is placed, and this is connected also with a graduated cylinder in which the gases resulting from the electrolysis of the water are collected and measured. In estimating by this instrument the relative intensities of currents, it is assumed that any two currents which decompose in a given time the same quantity of water are equal in intensity. In accordance with this principle it has been proposed to adopt, as a unit of the intensity of the current, that intensity which in one minute yields a cubic centimeter of mixed gas reduced to the temperature of 0° C. and the pressure of 760 millimetres of mercury. To render this mode of measurement more exact it would be better to measure the volume of the hydrogen alone, for oxygen is rather more soluble in water than hydrogen, and moreover it has a tendency to form ozone. Both these facts of course tend to reduce slightly the bulk of oxygen evolved in electrolysis.

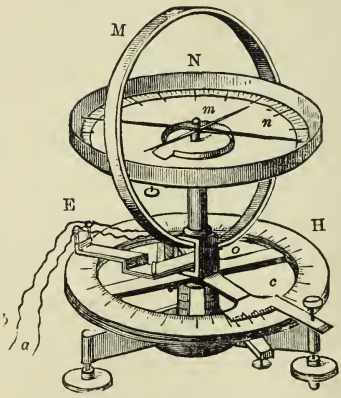


FIG. 82.—SINE GALVANOMETER.

In connection with the measurement of the electric current, certain very important laws have been enunciated which call next for our attention. The thorough investigation and formulation of these laws was effected by Professor Ohm, and they are accordingly known as Ohm's laws.

Ohm's laws.

Before giving these laws it will be necessary to explain certain of the terms employed in them.

First, then, it is agreed to call the force which in a cell or battery urges the current forward the *electro-motive force.*

Definition of terms.

Secondly, the term *resistance* is employed to denote anything which opposes itself to this *electro-motive* force; so that the strength of the current will be the electro-motive force as diminished by the resistance.

Thirdly, when a current is passing through a closed circuit, we are dealing with *dynamic* electricity (Greek *dunamos* = force).

Fourthly, when the circuit is broken the current ceases to flow, but the ends of the wires remain charged with *static* electricity (Latin *sto* = I stand).

Now, when a wire connecting the poles of a battery is broken, the static electricity at the ends of the wire can, as we have before explained, be measured, and it is found to be proportional to the strength of the current which passes through the wire when the wires are united. The *statical* electricity may in this way be taken as a measure of *dynamical* electricity.

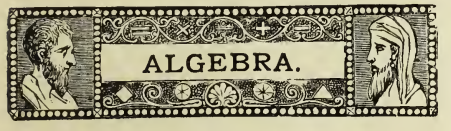
In measuring the tension of the electricity in different parts of a wire connecting the poles of a battery, it is found that when the middle point of such wire is connected with the earth, the tension of that point is *nil*, while right and left of this point the tension gradually rises up to the poles of the battery, where it attains its maximum. If any point of the wire other than the central point be connected with the earth, *it* becomes the zero point of tension, right and left of which the electricities increase in tension towards the poles of the battery. In both cases the electricity will, of course, be positive on one side of the zero point, and negative on the other.

If the negative pole of the battery be connected with the earth, the whole of

the wire shows positive electricity, and *vice versâ*.

Reduced length of the circuit.

There will, as before remarked, in every circuit be a *resistance* offered to the passage of the current, an opposition to the electro-motive force tending to reduce it. This resistance existing throughout the circuit will be partly in the conducting wire and partly in the battery itself. The latter resistance may be represented by a certain length of the conducting wire, and when this is done the sum of the lengths of both wires is called the reduced length of the circuit. If the reduced length of the circuit and the electro-motive force are known, the tension of every point of the circuit may be easily calculated.



VI.

Multiplication of Fractions.

The rule is the same as in arithmetic, and may be proved in a similar manner. *Multiply together the numerators for a new numerator, and the denominators for a new denominator.*

Example: Multiply $\frac{a}{b}$ by $\frac{c}{d}$.

Product of numerators is $a \times c = ac$, the new numerator; and product of denominators is $b \times d = bd$, the new denominator. The product of the two fractions is then $\frac{ac}{bd}$.

When we wish to multiply together a fraction and a whole number we apply the same rule, remembering that the denominator of every whole number is 1.

Thus, to multiply a and $\frac{c}{d}$ together.

$a = \frac{a}{1}$, $\therefore$ the product required is $\frac{ac}{1 \times d} = \frac{ac}{d}$.

Multiply together $\frac{a+x}{a-x}$ and $\frac{a+y}{a-y}$.

$(a + x) \times (a + y) = a^2 + ax + ay + xy = a^2 + a(x + y) + xy$

$(a - x) \times (a - y) = a^2 - ax - ay + xy = a^2 - a(x + y) + xy$

Therefore the product required is

$$\frac{a^2 + a(x+y) + xy}{a^2 - a(x+y) + xy}.$$

If we have to multiply together two or more fractional expressions, each of more than one term, such as $\frac{a}{x} + \frac{b}{y}$ and $\frac{x^2}{a^2} + \frac{y^2}{b^2}$, we may multiply term by term as in the multiplication of integers, or we may bring each fractional expression to an equivalent single fraction, and then multiply the numerators and denominators as directed above. According to the first method the operation would stand thus:—

$$\begin{array}{l} \frac{a}{x} + \frac{b}{y} \\ \frac{x^2}{a^2} + \frac{y}{b^2} \\ \hline *\frac{x}{a} + \frac{by^2}{a\,y} \\ \qquad\qquad \frac{ay^2}{b^2x} + \frac{y}{b} \\ \hline \frac{x}{a} + \frac{bx^2}{a^2y} + \frac{ay^2}{b^2x} + \frac{y}{b}. \end{array}$$

According to the second method, the common denominator of $\frac{a}{x}$ and $\frac{b}{y}$ is xy, and the expression becomes $\frac{ay + bx}{xy}$. The common denominator of the other expression is a^2b^2, and this expression becomes $\frac{b^2x^2 + a^2y^2}{a^2b^2}$. We have then to multiply together $\frac{ay + bx}{xy}$ and $\frac{b^2x^2 + a^2y^2}{a^2b^2}$. The product of the numerators is $ab^2x^2y + a^3y^3 + b^3x^3 + a^2bxy^2$, and of the denominators a^2b^2xy, and the whole product of the two fractions is $\frac{ab^2x^2y + a^3y^3 + b^3x^3 + a^2bxy^2}{a^2b^2xy}$.

This result is exactly the same as that obtained by the other method, as the student will find if he express the other result as a single fraction.

When a factor occurs in any numerator, and the same factor occurs in any denominator of the fractions to be multiplied together, this factor may be struck out from both fractions before multiplying, and much labour may often be saved by this means. The reason of this will be evident if we take an example. Suppose we have to multiply $\frac{ab}{c}$ and $\frac{d}{ae}$. The result, according to the rule of multiplication, is $\frac{abd}{ace}$, from which the factor a divides out of numerator and denominator, leaving $\frac{bd}{ce}$. But it is obvious that, having foreseen this, we might have divided by a *before* multiplying; and it is always well when we are dealing with complicated expressions to begin by striking out the common factors.

Thus, multiply together $\frac{(a+b)^2}{x+y}$ and $\frac{x^2-y^2}{(a+b)}$.

It is obvious that $a + b$ divides $(a + b)^2$, giving a quotient $a + b$. And since $x^2 - y^2 = (x + y)(x - y)$, $x + y$ divides $x^2 - y^2$, leaving a quotient $x - y$. The whole multiplication then is this:

$$\frac{(a+b)^2}{x+y} \times \frac{x^2-y^2}{(a+b)} = \frac{(a+b)(a+b)}{(x+y)} \times \frac{(x-y)(x+y)}{(a+b)}$$

$$= \frac{a+b}{1} \times \frac{(x-y)}{1} = (a+b)(x-y).$$

* The product of $\frac{a}{x}$ and $\frac{x^2}{a^2}$ is $\frac{ax^2}{a^2x}$, which becomes $\frac{x}{a}$ when its numerator and denominator are divided by their greatest common measure ax. Similarly, the last term $\frac{by^2}{b^2y}$ becomes $\frac{y}{b}$.

Examples.

1. Multiply $\frac{x}{y}$ into $\frac{2x}{4}$. Ans. $\frac{2x^2}{4y}$.

2. „ $2\frac{a^2}{x}$ into $\frac{z^2}{x^2}$. Ans. $\frac{a^2z^2}{x^3}$.

3. „ $\frac{4a}{6}$ into $\frac{3a}{2}$ into $-\frac{7a}{11}$. Ans. $\frac{-7a^3}{11}$.

4. „ $\frac{5c}{a^2}$ into $\frac{a^2b^2}{5cx^2}$. Ans. $\frac{b^2}{x^2}$.

5. „ $\frac{2x}{5}$ into $\frac{3ax}{6a^2}$ into $-\frac{7z}{11z^2}$.

Ans. $\frac{42ax^2z}{330a^2z^2}=-\frac{7x^2}{55az}$.

6. „ $\frac{a^3-b^3}{5b}$ into $\frac{3a}{a+b}$.

Ans. $\frac{3a^4-3ab^3}{5ab+5b^2}$.

7. „ $a+\frac{b-c}{d}$ into $b-\frac{b+e}{d}$.

Ans. $ab+\frac{b^2-bc}{d}-\frac{ab+ac}{d}-\frac{b^2-c^2}{d^2}$.

8. Multiply $\frac{a^2+b^2}{c+b}$ into $\frac{a-d}{c-d}$.

Ans. $\frac{a^3+ab^2-a^2d-b^2d}{c^2-d^2}$.

9. „ $\frac{3x^2}{5x-10}$ into $\frac{15x-30}{2x}$.

Ans. $\frac{45x^3-90x^2}{10x^2-20x}=\frac{9x^2-18x}{2x-4}$.

10. „ $\frac{\frac{2}{7}a-\frac{1}{3}b-6}{x-12y-2z}$ into $\frac{\frac{1}{7}a-\frac{1}{3}b+1}{\frac{3}{4}x-\frac{1}{4}y-6z}$.

Ans. $\frac{\frac{2}{49}a^2-\frac{1}{7}ab-\frac{4}{7}a+\frac{1}{9}b^2+\frac{5}{3}b-6}{\frac{3}{4}x^2-\frac{37}{4}xy-\frac{15}{2}xz+3y^2+\frac{5}{2}yz+12z^2}$.

Division of Fractions.

The rule is the same as in arithmetic, and is proved in a similar manner: *To divide one fraction by another invert the divisor and then multiply.*

Example: Divide $\frac{a}{b}$ by $\frac{c}{d}$.

Invert the divisor, and it becomes $\frac{d}{c}$.

Multiply together $\frac{a}{b}$ and $\frac{d}{c}$.

$$\frac{a}{b}\times\frac{d}{c}=\frac{ad}{bc}.$$

That is, $\frac{a}{b}\div\frac{c}{d}=\frac{ad}{bc}$.

If the divisor consist of several terms, it must be reduced to a simple fraction before it is inverted.

Thus: Divide $\frac{a}{b}-\frac{b}{a}$ by $\frac{a^2}{b^2}-\frac{b^2}{a^2}$.

$\frac{a^2}{b^2}-\frac{b^2}{a^2}=\frac{a^4-b^4}{a^2b^2}$, and this inverted is $\frac{a^2b^2}{a^4-b^4}$

Therefore we have $\left(\frac{a}{b}-\frac{b}{a}\right)\times\frac{a^2b^2}{a^4-b^4}$, which may be multiplied term by term, or by reducing the first factor to a simple fraction.

$$\left(\frac{a}{b}-\frac{b}{a}\right)\frac{a^2b^2}{a^4-b^4}=\frac{a^3b^2}{(a^4-b^4)b}-\frac{a^2b^3}{(a^4-b^4)}$$
$$=\frac{a^3b}{a^4-b^4}-\frac{ab^3}{a^4-b^4}=\frac{ab(a^2-b^2)}{a^4-b^4}=\frac{ab}{a^2+b^2}.$$

Or thus: $\frac{a}{b}-\frac{b}{a}=\frac{a^2-b^2}{ab}$.

Then we have $\frac{a^2-b^2}{ab}\times\frac{a^2b^2}{a^4-b^4}=\frac{ab}{a^2+b^2}$.

Instead of using the sign of division ($\div$), we may of course write the fractions in the form of a compound fraction, the dividend fraction being the numerator, and the divisor fraction being denominator.

Thus $\frac{\frac{a}{b}}{\frac{c}{d}}$ is the same as $\frac{a}{b}\div\frac{c}{d}$.

Find the value of $\frac{\frac{2ax-x^2}{c^3-x^3}}{\frac{2a-x}{(c-x)^2}}$.

$$\frac{\frac{2ax-x^2}{c^3-x^3}}{\frac{2a-x}{(c-x)^2}}=\frac{2ax-x^2}{c^3-x^3}\cdot\frac{2a-x}{(c-x)^2}$$
$$=\frac{2ax-x^2}{c^3-x^3}\times\frac{(c-x)^2}{2a-x},$$

which we may simplify by taking out $2a-x$ from the numerator of the first fraction and the denominator of the second, and $c-x$ from the denominator of the first and the numerator of the second fraction, because

$$2ax-x^2=x(2a-x) \text{ and } c^3-x^3$$
$$=(c-x)(c^2+cx+x^2).$$

We have then:

$$\frac{(2a-x)x}{(c-x)(c^2+cx+x^2)}\times\frac{(c-x)(c-x)}{2a-x}$$
$$=\frac{x(c-x)}{c^2+cx+x^2}.$$

Just as we could multiply multinomial fractional expressions term by term, so we can divide them term by term; and the student will find it of advantage to practise this, as in many cases it is much the shortest process.

Example: Divide $\frac{x}{y}+\frac{y}{x}+2$ by $x+y$.

$$x+y\Big)\frac{x}{y}+2+\frac{y}{x}\Big(\frac{1}{y}+\frac{1}{x}$$
$$\frac{\frac{x}{y}+1}{1+\frac{y}{x}}$$
$$\frac{1+\frac{y}{x}}{}$$

The various powers of a fraction are found just as are the powers of integers. Thus the square or second power of $\frac{a}{b}$ is $\frac{a}{b}\times\frac{a}{b}=\frac{a\times a}{b\times b}=\frac{a^2}{b^2}$. The fifth power of $\frac{a}{b}$ is $\frac{a}{b}\times\frac{a}{b}\times\frac{a}{b}\times\frac{a}{b}\times\frac{a}{b}=\frac{a^5}{b^5}$. The mth power of $\frac{a}{b}$ is $\frac{a^m}{b^m}$.

Examples of the Division of Fractions.

1. Divide $\frac{7x}{5}$ by $\frac{3x}{2}$. Ans. $\frac{14}{15}$.

2. $\frac{5a^2-5b^2}{a}$ by $\frac{10x+5a}{a^2-b^2}$. Ans. $\frac{a^4-2a^2b^2+b^4}{2ax+a^2}$.

3. $\frac{x^2+xy}{x-y}$ by $\frac{x^4-y^4}{x^2-2xy+y^2}$. Ans. $\frac{x}{x^2+y^2}$.

4. $\frac{9y^2-3y}{7}$ by $\frac{3y^2}{7}$. Ans. $\frac{3y-1}{y}$.

5. $a+b$ by $\frac{a^2-2b^2}{a-b}$. Ans. $\frac{a^2-b^2}{a^2-2b^2}$.

6. $-\frac{x^2-y^2}{a+b}$ by $-\frac{2xy-y^2}{a+b}$. Ans. $\frac{x^2-y^2}{2xy-y^2}$.

7. $\frac{x-x^{\frac{1}{2}}y^{\frac{1}{2}}+y}{\frac{1}{2}x^{\frac{1}{2}}+y^{\frac{1}{2}}}$ by $\frac{\frac{1}{4}x-\frac{1}{2}xy+y}{x^{\frac{1}{2}}+y_{\frac{1}{2}}}$.

Ans. $\frac{y^{\frac{3}{2}}+y^{\frac{3}{2}}}{\frac{1}{8}x^3+y^{\frac{3}{2}}}$.

8. $\frac{1+\frac{2x}{a}+\frac{2x^2}{a^2}+\frac{2x^3}{a^3}+\text{etc.}}{1-\frac{x}{a}+\frac{x^2}{a^2}-\frac{x^3}{a^3}+\text{etc.}}$ by $\frac{a+x}{a-x}$.

Ans. $\frac{a+x}{a}$.

9. $\frac{1-x+x^2-x^3+\text{etc.}}{a+ar+ar^2+ar^3+\text{etc.}}$ by $\frac{1-r}{+x}$. Ans. $\frac{1}{a}$.

XLIX.

Rule of Louis XIV. (*concluded*).

At the close of the seventeenth century the great topic that agitated Europe was the question of the succession of Spain. That country had degenerated to an inconceivable extent since the foundations of its greatness had been sapped by the policy of Philip II. Disorder in the finances, humiliation and defeat in military affairs, and a government dominated by Jesuits, had brought the once mighty monarchy to the verge of ruin. It was clear that the feeble Charles II. could not long survive. Four claimants to his inheritance appeared, all basing their pretensions on descent from or marriages with Spanish princesses. They were the Emperor Leopold of Germany, the Electoral Prince of Bavaria, the Duke Victor Amadeus of Savoy, and Louis XIV. himself.

Question of the Spanish succession.

Among the various candidates, Louis could perhaps put forward the best genealogical claim, as being the son of the elder daughter of Philip III., Anne of Austria — while the Emperor Leopold was descended from the younger daughter of that prince; but both he and his father, Louis XIII., had in the most solemn form renounced their rights to the succession to the throne of Spain. The question was felt to be one that might easily bring about a general war in Europe. Accordingly, with the concurrence of William III. of England, the first partition treaty was signed, by which the great Spanish inheritance was divided among the various candidates, without reference to the wishes of the king of Spain himself. The Dauphin, the son of Louis XIV., was to have Naples; Charles of Austria, the second son of the Emperor Leopold, the Milanese; France and Austria were to be indemnified by some detached provinces for the sacrifice of their claims; and Spain itself, the Low Countries, and the American possessions of the Spanish crown, were to descend to the Electoral Prince of Bavaria.

The candidates; first partition treaty.

But the death of the Electoral Prince at Brussels prevented the carrying out of this first partition treaty, which was accordingly superseded by a second, in which the Archduke Charles was to succeed to the rights of the deceased prince; the kingdom of the two Sicilies and Lorraine being transferred to France, and the Archduke undertaking that the Spanish monarchy should never be united to Austria, Hungary, and Bohemia.

Second partition treaty.

Charles II. of Spain, meanwhile, could not be kept in ignorance of the various arrangements for disposing of his inheritance; and he looked with indignation on the proposal to divide his territory and to dismember the Spanish monarchy. As his end approached, his mind was distracted with doubts and cares as to the testamentary dispositions he should make; while his dying bed was surrounded by the skilled agents of France and Austria, each endeavouring to influence him to execute a will in favour of the power they respectively represented. At length, in 1700, the poor king died; and when his will was solemnly opened, it was found that he had left the vast inheritance of the Spanish crown to Philip of Anjou, the second son of the Dauphin, and grandson of Louis XIV.

Will of Charles II. of Spain.

This splendid legacy filled the French court and the nation generally with pride and exultation. It was then that Louis declared "*Il n'y a plus de Pyrénées.*" There was no longer any barrier between France and Spain. And although the various powers were alarmed and disconcerted, he would probably have been allowed to place his grandson on the throne unhindered, but for an almost unaccountable piece of imprudence, by which he threw down the gauntlet of defiance to all Europe. Just at that time the exiled James II. died at St. Germains; and Louis acknowledged his son, Prince James, (afterwards extensively known as the Old Pretender) as king of England. This proceeding, which was an entire repudiation of the treaty of Ryswick, left no other course open to William III. but to declare war against his old enemy. Then was brought about that grand alliance between England, Holland, and the Emperor Leopold, with the object of placing the Archduke Charles, Leopold's second son, on the Spanish throne:

Death of James II. Louis acknowledges "James III."

The grand alliance.

and the fatal closing period of Louis' long reign began with the great war of the succession of Spain. Prussia, Portugal, and Savoy, soon swelled the numbers of the grand alliance, whose great material resources were directed by the genius of the two greatest soldiers of that warlike time—John Churchill, Duke of Marlborough, and Prince Eugene of Savoy, son of Olympia Mancini, one of the nieces of Mazarin. To these Louis had to oppose Villars, Boufflers, Catinat, Villeroy, and Vendôme, distinguished generals, among whom Catinat and Vendôme were the greatest.

While the preparations were still in progress for the great strife, William died; but his successor, Queen Anne, whose right to the throne had, equally with his own, been denied by the French king, had no choice but to adopt the alliance and the war. From the commencement fortune went against the house of Bourbon and the new king of Spain, who as Philip V. now took up his abode in Madrid, while his Austrian rival assumed the title of Charles II. In Italy Eugene defeated Villeroy; and though checked for a time by the genius of Vendôme, succeeded ultimately in driving the French from Lombardy. In Spain itself an English expedition resulted in the destruction of the Spanish fleet in Vigo Bay; and this was followed by the important capture of Gibraltar by the enemy. In 1704 the tremendous defeat of Hochstedt or Blenheim inflicted such a blow upon France as it had not experienced for centuries; and this great triumph of Marlborough was followed up in 1706 and 1708 by the victories of Ramilies and Oudenarde, and later by the defeat of Villars at Malplaquet. In Spain again the genius of Mordaunt, Earl of Peterborough, prepared disaster for Philip of Anjou, who was even obliged to fly from his capital; until the defeat of Lord Galway, Peterborough's successor, at Almanza, brought a gleam of comfort. Meanwhile, the exhaustion of France became greater year by year. The cruel winter of 1709 kept the rivers of France frozen for more than four months, destroyed the olives, vines, and fruit trees, ruined the harvest for the next year, and brought famine to increase the woes of the wasted and stricken nation; and as bread became scarcer, popular discontent increased, and swelled to the stage of rebellion. Deeply humiliated, the aged monarch, who had been once the arbiter of Europe, abased himself so far as to sue for peace, offering to abandon the cause of his grandson in Spain; but the allies demanded nothing less than that he should send troops to dislodge Philip V. from Spain. This was going too far. "If I must make war," said Louis, with a touch of his old pride, "I would rather fight for my children than against them." At last the boundaries of France itself were crossed by the fiery Eugène. The king was advised to retire beyond the Loire; but he declared that rather than do this, he would mount his horse and die at the head of his army.

Death of William III. War of the succession of Spain.

Disaster of Louis; Blenheim, etc.

Peterborough in Spain.

Louis XIV. sues for peace.

In his own family, too, he had to suffer bitter bereavement. The dauphin, his only son by Maria Theresa of Spain, died of small-pox, in 1711, at the age of fifty; and within a very short time afterwards, the Dauphin's son, the Duke of Burgundy, died also. He was followed by the two elder of his three sons; so that his youngest, an infant in the cradle, the surviving great-grandson of Louis, was the next heir to the French crown. In this series of lamentable deaths, many of the discouraged people saw omens of the fall of the monarchy.

Family misfortunes.

DUKE OF MARLBOROUGH.

But hope now dawned from an unexpected quarter. Death had been busy in other royal houses besides that of France. The Emperor Leopold had died in 1705, and was followed, in 1711, by his eldest son and successor Joseph; and thus the Archduke Charles succeeded to the vast territories of the Austrian house, and became Emperor of Germany. This produced a change of policy in England, where the Tories, with whom Marlborough was unpopular, were glad of an opportunity of terminating the war.

Death of the Emperor Leopold; results.

The genius of Vendôme had moreover once more conquered fortune in Spain, by gaining for the king, Philip V., the victory of Villa Viciosa, in New Castile; while the triumph of Villars, at Denain in Hainault, materially improved the position of the Bourbon house. A change of ministry in England had meanwhile brought the Tories into power; and they declared, not without show of reason, that to establish Charles VI. on the throne of Spain would bring about the very state of things they had been fighting so long to prevent—the union of two great empires under one ruler; and that Spain joined to Austria would be as dangerous to the security of Europe as Spain joined to France.

Villa Viciosa and Denain.

Accordingly in 1713 the great struggle was concluded by the treaty of Utrecht, in which

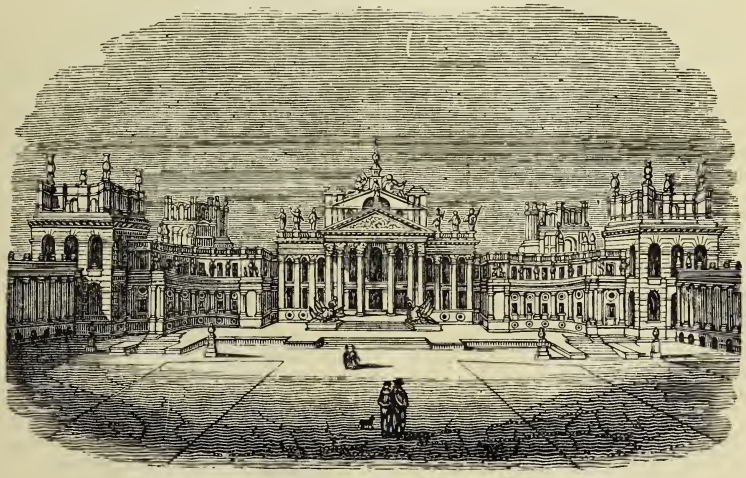
it was agreed that Philip V. should be acknowledged king of Spain on condition that he and his grandfather renounced all pretensions to the thrones of France and Spain respectively; that Louis should undertake to fill up the harbour of Dunkirk, to recognise the Act of Succession in England, and to cede to England the districts of Acadie and Newfoundland in North America. A treaty of commerce was in addition to be concluded between France, England and Holland; England was to retain Gibraltar and Minorca; and the Duke of Savoy to receive Sicily, the Milanese, Sardinia, and the Netherlands. The emperor refused to acquiesce in this peace, and Eugene fought on, in his service. But Villars gained successes in Swabia, taking Spires, Worms, and Landau, and forcing the lines of Eugene before Freiburg in Breslau; and at length Leopold saw the necessity of concluding the long strife; and at Rastadt, in Baden, Villars and

Treaty of Utrecht, 1713.

brow the round and top of sovereignty." Especially he recommended the child—who could hardly be expected to have understood him—to pursue peaceable counsels, and to avoid expensive wars. He might well give that counsel; for unjust war and aggression had been his ruin.

He died on the 1st September, 1715, within four days of completing his seventy-seventh year. His nominal reign extended over seventy-two years; practically he had swayed the destinies of France for about fifty-five years. "Europe had never seen so long a reign," writes Sismondi, "nor France so aged a king." The effects of his rule were seen in the deluge that swept away the French monarchy in 1792. France had been overtaxed and overdriven, in spite of her great resources; and in the war of the Spanish succession the gains of earlier times had been swept away.

His death, 1715.



BLENHEIM HOUSE.

Eugene signed a treaty by which the last scene of the long and disastrous war was at length closed, in 1714. The same year died Vendôme and Catinat, the two most illustrious leaders in the latter part of the war.

Treaty of Rastadt, 1714.

Thus the aged king had at last the satisfaction of seeing the termination of the disastrous struggle his ambition had brought upon France. His long wars had completely exhausted the country, whose destinies he had aspired to guide without deigning to listen to the advice of wiser men than himself. He had at length learnt the lesson of the vanity of human wishes, as connected with war and glory. He did what he could during his last days to set his house in order, by appointing a council of regency, under the presidency of the first prince of the blood, the Duke of Orleans, to manage affairs during the minority of the little king of four years old—the infant great-grandson, who was to "wear upon his baby-

End of the reign of Louis XIV.

VII.

Chaucer and his Writings (*continued*).

The earlier works of Chaucer are chiefly translations from the French: the poet seems at first to have followed his originals pretty closely; but as his genius expanded, his thoughts and expressions became more original. *The House of Fame*, a fine allegorical poem, was the source whence Pope derived his *Temple of Fame*; and, indeed, Pope showed his appreciation of Chaucer in more ways than one; but especially in his "imitations." *The Flower and the Leaf* contains much graceful verse, and is the most admired among the author's minor works. *The Dream*, *Troilus and Cresseida*, and the before-mentioned *Testament of Love*, are

prominent among his other works. The *Romaunt of the Rose*, also translated from the French, is remarkable for the faithful and spirited rendering. The Garden of Mirth, or of Love, in which grew the Rose, the object of the lover's wishes and labours, was enclosed with embattled walls, richly painted with various figures, such as Hatred, Avarice, Envy, Sorrow, Old Age, and Hypocrisy. Sorrow is thus represented :—

The Romaunt of the Rose.

"Sorrowe was pantid next Envie
Upon that wal of masonrie.
But wel was seen in her colour,
That she had livid in languour;
Her seemid to have the jaundice,
Not half so pale was Avarice.
Ne nothing alike of lenesse
For sorowe, thought, and grete distresse.
A s'rowful thing wel semid she;
Nor she had nothing slow ybe
For to bescrachin of hir face,
And for to rent in many place
Hir clothes, and for to tere her swire (neck),
As she that was fulfilled of ire:
And al to torn lay eke hir here,
About hir shoulders, here and there;
As she that had it all to rent
For angre and for male talent."

A comparison with the French original will illustrate at once the fidelity of the translation, and the ingenuity of Chaucer in adapting French words to the English language. The corresponding lines run thus :—

The French original.

"De les Envie etoit Tristesse
Painte aussi et garnye d'angoisse.
Et bien paroit a sa couleur
Qu'elle avoit a cueur grant douleur:
Et sembloit avoir la jaunice,
La n'y faisoit riens Avarice,
Le palisseur ne de maigresse
Car le travaile et la destresse, &c.
Moult sembloit bien que fust dolente:
Car el n'avoit pas este lente
D'esgratignier toute sa chiere;
Sa robe ne luy estoit chiere
En mains lieux l'avoit dessiree,
Comme culle qui fut yree.
Ses cheveulx derompus estoient,
Ou'autour de son col pendoient,
Presque les avoit tous desroux
De maltalent et de corroux."

At last, after many perils and labours, the lover, having scaled walls, crossed ditches, and forced open the closed gates of castles, reaches the garden, and gathers the rose.

In the *House of Fame* we have represented an enormous hall crowded with men of every nation and of every rank, all presenting to the queen of the place their petitions for future consideration, setting forth their claims to immortality. Of Pope's imitation of this poem a critic has said, in reference to the attempt of the poet of the eighteenth century to correct the extravagances of him of the fourteenth: "An attempt to unite order and exactness of imagery with a subject formed on principles so professedly romantic and anomalous, is like giving Corinthian pillars to a Gothic palace. When I read Pope's elegant imitation of this piece, I think I am walking among the modern monuments unsuitably placed in Westminster Abbey."

Chaucer's House of Fame.

The Testament of Love is written in prose; the author's tone of mind is here in consonance with the melancholy nature of his fortunes at the time; and he moralizes, in a meditative strain, on the things of this life, and the principles by which a man should be guided in his worldly career. Thus, in speaking of worldly wealth, he pithily remarks: "In getting riches ye musten flee idleness; and afterward ye shuln usen the riches which ye han geten by your wit and by your travail, in such manner, that men hold you not too scarce, ne too sparing, ne fool-large, that is to say, over large a spender; for right as men blamen an avaricious man because of his scarcity and clinchery, in the same wise he is to blame that spendeth over largely."

The Testament of Love.

The work of Chaucer which dwarfs all his other productions by standing forth as a giant among them,—the work which gave the literary character to its century, and by which the author will always be judged,—is *The Canterbury Tales*. In this great work the poet has left us such a picture of the manners, customs, dress, and appearance of men of various classes in the fourteenth century, as we can nowhere else find. It is a series of portraits of the English, painted by one of themselves; and we seem to sit in the great kitchen or common room of the jolly inn-keeper, and to hear the very voices of the guests, their loud jests and frank laughter, as they are introduced to us one after another. The scheme of the work is manifestly taken from Boccaccio, the Italian poet, who in his *Decameron* has introduced a company of friends who tell stories to beguile the time, the tales amounting to a hundred in all. But Chaucer, though he borrows the chief idea, makes it all his own by originality of treatment.

The Canterbury Tales.

The introductory part, with its explanation of the scheme of the poem, and description of the various characters, is inimitable. Chaucer tells us how, in the spring-time, when the sweet showers of April have pierced the drought of March to the root, "And smallé foulés maken melodie, that sleepen all night with open eye, so priketh hem natúre in hir corages,"—at that sweet season of the year the author sets forth on a pilgrimage to the shrine of Thomas à-Becket, at Canterbury. He purposes to start on his pious journey from the tavern called the "Tabard" (the herald's coat, a sign afterwards corrupted into the "Talbot," or hunting-hound); and at that hostelrie there are assembled a goodly company of nine-and-twenty guests, all purposing to visit Canterbury to pray at good St. Thomas's shrine. The poet makes acquaintance with them all; for he tells us that

"Shortly, whanne the sonne was gone to reste,
So had I spoken with them everich on,
That I was of hir felowship (their fellowship) anon."

And then he proceeds to inform the reader of the "condition and degree" of each of them, and portrays their characters in a series of sketches, invaluable in an antiquarian point of view, and marvellous in their quick observation, eloquent word-painting, and genial humour.

First and foremost, as becomes his degree, comes the man of greatest honour in the company—the "veray parfit gentil Knight."—the mirror of courtesy, who never said "no manare villanie" to any man in his life—who is wise, experienced, and thorough, but yet "of his port as meke as is a mayde,"—who has fought in various parts of the world against the infidels of Lithuania—probably in conjunction with the Teutonic order of knights,—against the Saracens in the Holy Land, and against the enemies of his country in Spain, and elsewhere. His horse is good, but his apparel is sober and unassuming. He is the thorough personification of a gentleman, and we are told how

Portraiture of the Knight.

"Fro the time that he firste began
To riden out, he loved chevalrie,
Trouthe and honour, fredom and curtesie,
Ful worthy was he in his Lordes werre (war),
And therto hadde he ridden, no man ferre (farther),
As wel in Christendom as in Hethenesse,
And ever honoured for his worthinesse."

His son, the young Esquire, at an earlier period of life, naturally lacks the gravity and simplicity of the "gentil knight." He is a bit of a coxcomb; very gay in his apparel, in a period of fantastic dress; he is "the lover, sighing like furnace, with a woeful ballad made to his mistress's eyebrow," and evidently has not yet cast off the weaknesses of youth,—"a little wilfulness, and a little selfishness, and a little dandification," as Thackeray expresses it; but he has already seen military service on the Continent of Europe, is "courteous, lowly, and serviceable," and may in time develop into as perfect a knight as his father.

The Esquire.

"And he had been sometime in chivauchie (exercise)
In Flandris, in Artois, in Picardie;
And born him wele, as of so littill space,
In hope to standin in his ladies grace.
Embroudid was he as it were a mede
All ful of fresh flouris both white and rede.
Singing he was and floityng al the day,
He was as fresh as is the month of May.
Schort was his gown, with slevis long and wide,
Wel couth he sit an hors, and faire yride.
And songis couth he make, and wel endite,
Just (joust), and eke daunce, and wel portraie, and write."

Then comes the Yeoman in his green hood and coat,—a strong man and a trusty, with his tough yew bow and sheaf of arrows, a right dangerous man to meet in battle,—"a not-hed hadde he,"—he was a bullet-headed man, a sturdy Englishman to the core.

The Yeoman.

The Prioress is good-naturedly described, but not without a touch of sly humour. There is a certain amount of affectation about the good lady, who weeps if she sees a mouse caught in a trap, "if it were dead, or bled." She evidently prides herself not a little on her manners, learnt at the "scole at Stratford atté Bowe"; but she is thoroughly good-hearted, and represents the prosperity of the Church,—a comfortable, easy-going form of religion. Her character is given thus:—

The Prioress.

"There was also a nun, a Prioress,
That of hire smiling was full simple and coy,—
Hire greatest oathé, n'as but by St. Loy (Eloi)!
And she was clepèd (called) Madame Eglantine.
Ful wel she sangé the service devine,
Entunèd in hire nose ful sweetèly;
And French she spake, ful fair and fetisly (cleverly),
After the scole of Stratford atté Bow—
For French of Paris was to her unknow.
At meaté was she wel ytaughte withale—
She lette no morsel from her lippes falle,
Ne wette hire fingres in her saucé depe;
Wel coude she carrie a morsel, and wel kepe
Thatté no drope ne fell upon hire breast.
In curtesie was sette ful much hire lest (wish);
Hire over-lippé wipèd she so clene,
That in hire cuppé was no ferthing (fragment) sene
Of gresé, when she dronken hadde hire draught.
Full seemèly after hire meat she raught (reached),
And sikerly (surely) she was of grete disport,
And ful pleasant, and amiable of port,
And peinèd hire (pained her) to counterfeiten chere
Of court, and ben estatelich of manere,
And to ben holden digne of reverence."

A Monk, in the company, is described in a vein of sly humour. The portraiture of this clerical personage is evidently intended by Chaucer as a satire upon the luxurious and pleasure-seeking habits of the ecclesiastics of his time. The monk might have been a follower of the Prior of Jorvaulx in Scott's *Ivanhoe*. This jolly monk is a lover of venerie, or hunting, a keeper of greyhounds and horses, and a man with a thorough appreciation of the good things of this world, and a devout horror of asceticism. The poet tells us of him:—

The Monk and the Friar.

"He yave not of (gave not for) the text a pulled hen,
That saith that hunters ben not holy men;
Ne that a monk, whan he is rekkeles,
Is like to a fish that is waterles;
That is to say, a monk out of his cloistre.
This ilke text held he not worth an oistre.
* * * *
And for to fasten his hood under his chinne
He hadde of gold ywrought a curious pinne:
A love-knotte in the greter ende ther was.
His hed was balled, and shone as any glas,
And eke his face, as it hadde ben anoint.
He was a lord ful fat and in good point.
* * * *
He was not pale, as a forpined gost,
A fat swan loved he best of any rost."

A Friar who is very popular with the citizens' wives, whom he compliments with presents of knives and pins,—a well-fed, well-dressed, jovial man, whose eyes twinkled in his head "as doe the sterres (do the stars) on a frosty night," gives the poet another opportunity for a capital piece of satire.

Then comes the Sompnour, or Summoner, a truculent-looking fellow, of whose fiery red face "children were sore aferd." His office was to summon unfortunate folks for offences against the church; and we are told how this worthy officer had picked some two or three Latin terms out of a decree, and made a great parade of these, and especially when he "wel dronken had the win (wine); then wold he speken no word but Latin." Nevertheless, this formidable personage was to be propitiated by offerings of his favourite beverage, and for "a quart of wine" would wink at many irregularities.

Upon the Pardoner, or seller of indulgences, who was the great "friend and compeer" of the Sompnour, the poet's satire is chiefly poured out. This notable person is described as riding about with a wallet. "Bret ful of pardon come from Rome al hote," "and in a glas he hadde pigge's

The Pardoner.

bones," which he exhibits as relics, and by exhibiting these he got more money in a day than a country parson could get in two months,

"And thus, with fained flattering and japes,
He made the persone, and the peple, his apes."

The Wickliffite leanings of the poet are clearly seen in the personages he portrays as the opposite of those ecclesiastical personages.

The parish clergyman.

The poor clergyman of the parish, the parson or persone, represents the true worker in the Master's cause—the shepherd who is no hireling, and who cares for the sheep. "He was a shepherd and no mercenarie,"—one who believed that example did more than precept towards enforcing holiness of life. Perhaps the most charming picture in the whole poem is that of the patient, laborious, honest priest, "more bent to raise the wretched than to rise,"—ready in sickness or misfortune to visit the farthest dwellers in his wide parish, trudging across the country with his trusty staff. Especially the poet takes care to contrast him with those who made their clerical calling a means of worldly advancement; for we are told,—

"He sette not his benefice to hire,
And lette his shepe acombred in the mire,
And ran unto London, unto Seint Poules,
To seken him a chanterie for soules,
Or with a brotherhede to be withold;
But dwelt at home, and kepte wel his fold,
So that the wolf ne made it not miscarie.
He was a shepherd, and no mercenarie:
And though he holy were and vertuous,
He was to sinful men not dispitous,
Ne of his speche dangerous ne digne,
But in his teching discrete and benigne.
To drawen folk to heaven with fairenesse,
By good ensample was his besinesse.
* * * *
He waited after no pompe ne reverence,
Ne maked him no spiced conscience,
But Criste's love and His apostles twelve,
He taught, but firste he folowed it himselve."

VII.

SOUND (*continued*).

IT is found that when an open tube sounds its fundamental note, each end of the tube is the middle of a ventral segment, whilst the centre is a node. When the first overtone is sounded there are two nodes, one being situate at one-fourth of the length of the tube from each end. In sounding the second overtone, the air is divided by three nodes, one in the centre and one at one-fifth of the length of the pipe from each end. Bearing in mind the rule given above, it will be seen that the number of vibrations of the notes produced will be in the order of the even numbers 2, 4, 6, etc., these latter numbers representing the number of semi-ventral segments respectively in each division of the air-column within the tube. In fig. 31 is shown the condition of the air in open tubes when sounding respectively the fundamental and the first and second overtones.

Divisions of open tubes.

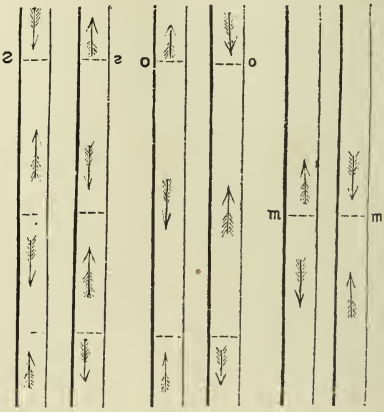


FIG. 31.

In both closed and open pipes the number of vibrations per second is inversely proportional to the length of the pipe. From a knowledge of the manner in which the air divides itself in organ-pipes, it is a comparatively easy task to devise a method of measuring the velocities of sound in various bodies. It will be noticed by the reader that the divisions of an open organ-pipe and of a rod free at both ends are the same; and it will therefore follow that if a rod of wood be taken, and the sound it emits compared with that of an organ-pipe of the same length, the difference in the pitch (if any) will be due to a corresponding difference between the velocity of sound in air and its velocity in the kind of wood used. Taking a rod of pine, it is found that this difference is as 10 to 1, so that it follows that the velocity of sound in pine is ten times what it is in air, or about 10,900 feet per second. In like manner different gases may be forced through organ-pipes, and their pitch compared in order to deduce their respective velocities. If oxygen and hydrogen gas be forced successively through the same tube, the respective notes are approximately as 1 to 4, which is the ratio of the velocity of sound in oxygen to that in hydrogen. In like manner the velocity of sound in liquids may be ascertained by forcing them through properly constructed tubes.

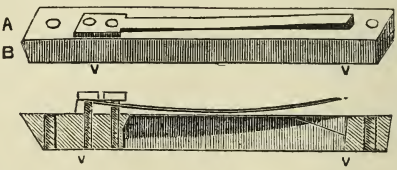


FIG. 32.

Associated with organ-pipes are frequently found what are termed "reeds." A reed consists essentially of a flexible metallic tongue free at one end, and capable of being set in motion by currents of air. A reed as ordinarily employed in such instruments as the concertina, harmonium, etc., is represented in fig. 32. The function of the reed is to mould into vibrations or "puffs" the

Reeds.

current of air which but for them would be continuous; it is the vibrations of the air, and not of the reed, which produce a musical sound. When reeds are attached to organ-pipes, if stiff they rule the air-column, if flexible they are ruled by the air.

Construction of organ pipes.

In fig. 33 is shown an organ-pipe with one of its sides removed in order that its inner parts may be seen. The pipe is made to speak by driving the air up the tube *t*, which communicates with the wind-chest, into the chamber C, the top of which has a narrow outlet, *e d*, to the pipe P. Only a thin sheet of compressed air can pass through *e d*, and this then strikes upon the sharp edge, *a b*, causing a flutter; by the resonance of the pipe the proper pulse of this flutter is raised to a musical sound, and the pipe "speaks." Fig. 34 represents an organ-pipe with a reed attached. A conical pipe, A B, surmounts the reed, and pressing against the latter is a wire, *w i*, which is employed to lengthen or shorten it. The clarionet is a reed pipe; a flute is an open pipe; in the hautboy and bassoon there are two reeds inclined at an angle to each other, and having a slit between them through which the air is forced. The human voice apparatus is a reed instrument; but for a description of this wonderful piece of Nature's mechanism we must refer our readers to the chapters upon Anatomy in the UNIVERSAL INSTRUCTOR.

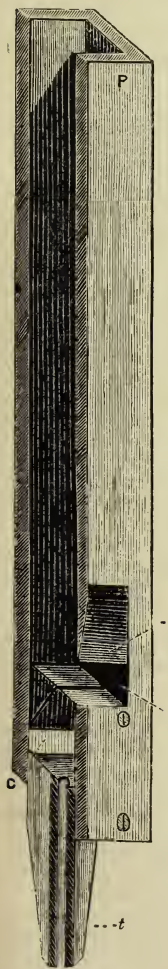


FIG. 33.

Beats.

When two notes of any instrument very close in pitch to each other are sounded together, there is heard an alternate strengthening and enfeeblement of the sound, which produce what are known as "beats." These may be illustrated in various ways. If a note of the piano and its sharp or flat be sounded together beats are distinctly heard; if the same notes are simultaneously sounded on different instruments which are not quite in tune, beats will be heard; if of two tuning-forks which are in unison one be loaded by putting a small piece of wax upon one of the prongs, they will, when sounded together, produce beats.

What is the cause of these beats? The answer to this question may be obtained by considering briefly what happens very frequently in every pond or pool. If a stone be thrown into a pond, as is well known, it produces a series of circular waves, which spread out in a succession of concentric waves, which get fainter and fainter as they reach the margin of the pool. Let us suppose, instead of one such stone being thrown in, that *two* are dropped at a short distance from each other into the pond. Two sets of circular waves will thus be generated, and, if sufficiently close together, part of one set will interfere with part of the other set. In order to understand thoroughly the nature of this interference we must bear clearly in mind the exact nature of wave-motion. To any one standing on the beach and watching the billows as they roll in towards the shore, it is natural to suppose that there is an actual motion of translation in the water itself, and that not merely the wave, but the water itself, travels from the distant horizon and topples over at one's feet. It must, however, be clearly understood that the only motion of the particles of water is one in a vertical direction, each particle being first raised above and then sinking below the average level, and after thus oscillating for a few moments, subsiding to rest; the *form* of the wave travels, not the surface of the water over which it passes. The last portion of water topples over at our feet, because it has no other water to which it can impart the impulse it receives.

Interference.

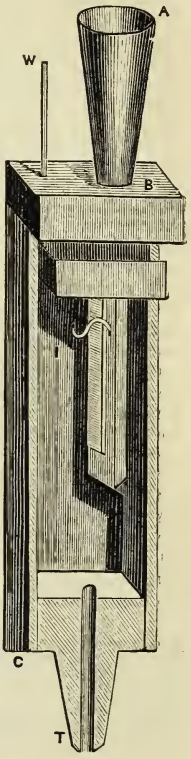


FIG. 34.

Bearing in mind the nature of wave motion

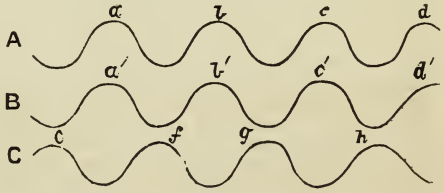


FIG. 35.

in general, it will be seen that if two sets of adjacent waves start simultaneously (each having the same wave length), the interfering segments of each set will coincide with each other, and the result will be a dou-

Influence of water waves on one another.

bling of the disturbance of the water. In fig. 35 the series of waves would obviously coalesce, the crests *a b c d* of A coinciding with the crests *a' b' c' d'* of B. But if, as in B and C, one series of waves be half a wave length behind the other, it is equally obvious that the crests of one set will coincide with the sinuses of the other set; in the first case the two sets of waves will coalesce and produce waves of double height, while in the second case the waves will be antagonistic to each other, and tend to move the particles of water in opposite directions, at the same time destroying each other's motion, and equilibrium will be established—that is, no motion of the water will result. A little consideration will show that if one set of waves be any number of *whole* wave lengths, or any *even* number of half wave lengths behind the other, the two sets will coincide, but if one set be any *odd* number of half wave lengths behind, they will oppose each other. What has been said with regard to water waves applies precisely to sound waves. If two sets of sound waves are perfectly synchronous, a strengthening of the sound is produced; if one set differs from the other by any odd number of half wave lengths, they interfere, and either partially or totally destroy each other, and thus by adding sound to sound silence may result. It is, of course, easy to see that two sets of waves may be so related as sometimes to coincide with, at other times to oppose, each other, and so produce the phenomena of beats.

EDUCATION FOR YOUNG WOMEN.

II.

Colleges for Women—Examinations for Women.

We have hitherto spoken of work which girls may do at home, and of the mode of private study, but of course it is better to have instruction from one who has already gone over the ground. The teacher is a book that can be questioned, and in this undoubtedly lies the strong point of teaching. Care, however, must be taken not to fall into the error of imagining that a teacher should, so to speak, pour knowledge into you while you do nothing but respectfully assume the attitude of a receiving vessel. The best teacher in the world cannot educate a scholar who does not work and think and is not thoroughly in earnest. A teacher should, at any rate at the age at which a girl usually leaves school, be but a help and a guide in the efforts made by the student.

All work should be as diligently performed as if no teacher were expected to lend a helping hand later on. Do not rely on the tutor as a prop, or as a substitute for yourself; and while receiving instruction on a subject, do not omit to revise the work already done, otherwise it is impossible to make sure of gaining solid and enduring advantage.

Of the kinds of teaching, that given to a class is the most beneficial, for the natural emulation which arises is a useful stimulus to exertion; and much is to be learnt from the correction of the mistakes made by others as well as ourselves. Undoubtedly, however, some timid students who fear to face the fire of a class would gain ground better under private instruction. This can often be obtained at a moderate cost.

Of late years numerous "correspondence classes" have been formed, which have proved exceedingly useful to country students who have had no opportunity of attending classes or lectures, and to whom private instruction may have been equally unattainable. A tutor undertakes the guidance of the student in a particular subject or subjects, usually having reference to some examination, and sends out instructions as to the course of reading requisite; and the pupil may write to a tutor for advice in cases of difficulty. Questions are regularly forwarded to be answered by the student, who receives them again corrected by the teacher. Thus it is possible to estimate the progress that is being made, to a considerable extent.

An excellent system of correspondence is maintained in connection with Newnham College, Cambridge; this course is especially intended to promote the self-education of women and to assist them in preparing for the Higher Local examination of the University. This is mentioned as one out of a number of excellent arrangements now practicable, by which those who are at a distance may not feel themselves cut off from help. A little inquiry, and consulting the advertising columns of the literary and daily journals will usually give the student the opportunity of choosing that mode of instruction which she thinks most suitable for her own particular case.

In nearly all large towns at the present day, either there are colleges established on a permanent foundation, or there are courses of lectures given on important subjects of education under the guidance of local committees, and in connection with the great Universities. Almost all the classes are open to women, and very many deal with subjects most desirable for women to study. Usually there is a lecture once a week on a definite subject, and a class follows it, at which questions are asked, and the written answers to previous questions are discussed and criticised.

There are few who cannot afford time to keep up with at least one class, and it is worth while to make a struggle to gain such instruction. Do not be deterred by the fact that it requires an hour's walk to get to the lecture hall, or that you may have no companion in your own circle who cares to pursue the same course. Very likely your example may stimulate some friend at a future time, if not now, to set about the task of self-improvement. Try not to be discouraged if you seem to make little progress at first. All the time you appear to spend fruitlessly is occupied with learning how

to study, which in itself is no insignificant acquirement. By all means regularly answer questions which are set: even though you may be able to do very little in that way, a little will soon become more, and you will feel pleasure instead of vexation, a sense of victory instead of one of discomfiture, when you discover that you have a real grasp and comprehension of a subject which was previously unknown to you.

Another valuable means of instruction open to women is afforded by the Science and Art classes now spread throughout the country in connection with the Government Department of Science and Art at South Kensington. In these classes continuous instruction is provided, by which many subjects in succession can be mastered, and the fees payable are within the reach of all.

A girl need not feel herself obliged to enter for a formal examination because she attends lectures or classes; and some no doubt educate themselves without the stimulus an examination affords. At the same time, where a girl has opportunity combined with good health, it is advisable to go in for some examination. She may not pass, and yet may gain great benefit from being examined. Some, no doubt, have not the natural qualifications for examination; they have not the coolness and self-possession so necessary to the examinee. They may know their subjects, and yet be unable to reproduce their knowledge in an examination hall. These need hardly trouble about examinations. But no doubt those girls who may have to earn their own living should try and pass something; and what girls are sure that fortune will always smile upon them and prevent their ever having to battle with the world for themselves? A girl cannot now-a-days get remunerative employment in intellectual work unless she can produce some proof of her attainments in the shape of a certificate of examination. And supposing a girl never does need to earn her own living, even then she secures for herself a *locus standi*, and betters her position vastly by having been successfully examined.

There is now no barrier hindering any woman because of her sex from ascertaining the exact value of her attainments, according to the same standard by which men are judged. In nearly all the examinations now open to women, men are candidates at the same time; and success in these examinations means that evidence of a certain amount of work and a certain quality of brain has been shown in the answers. If any girl fears an examination, being oppressed by the idea that men can naturally do intellectual work better than women, she should reflect that the ordinary type of man is *not* fond of intellectual effort, and that perseverance and patience will in a short time certainly place her above the commonplace members of both sexes. Moreover, successes attained by women show that this mark has been reached by many, and examiners have acknowledged over and over again that the mind of woman displays characteristics quite as deserving of respect as that of man.

All the examinations of the University of London are open to women, and degrees in arts, sciences, law, medicine, and music may be attained by them. The conditions of the examinations, and all the questions for one year, are contained in the Calendar of the university, published early every year; and the regulations and subjects for any particular examination can be obtained in the form of a small pamphlet from the Registrar of the University, Burlington Gardens, London. A degree cannot be obtained in a short time, but the examinations are open without any condition that the candidates shall have studied at a particular college, or at any college at all. It is necessary first to pass the matriculation examination, having produced a certificate of being at least sixteen years of age. A fair knowledge of Latin, and of two of the following three languages, Greek, French, and German; of English language and history, and modern geography; of arithmetic, elementary algebra, and geometry (the subjects contained in the first four books of Euclid); and of elementary natural philosophy and chemistry, is required. The examinations are held twice a year, in January and June, not only in London, but in some provincial centres, such as Manchester, Birmingham, and Bristol.

The examinations for the Arts degrees (B.A. and M.A.) require more advanced knowledge in mathematics, languages, and mental philosophy. The Science degrees (B.Sc. and D.Sc.) include almost the whole range of sciences which can be satisfactorily studied by all, but in the later examinations it is necessary to choose a few sciences for more thorough study.

To attain a medical degree it is requisite to study at a medical school, and for this purpose the only available place in England is the London School of Medicine for Women, established at Henrietta Street, Brunswick Square, W.C., the pupils of which receive instruction also at the Royal Free Hospital, in Gray's Inn Road. The Secretary of the School will always gladly furnish information about it to those who apply to her.

Nearly all British universities have established examinations for which women may be candidates. At Oxford there are examinations specially for women, the particulars of which may be learned of the Secretary. The Cambridge Higher Local examination is open to non-resident students of both sexes, and it is held at several populous centres besides Cambridge.

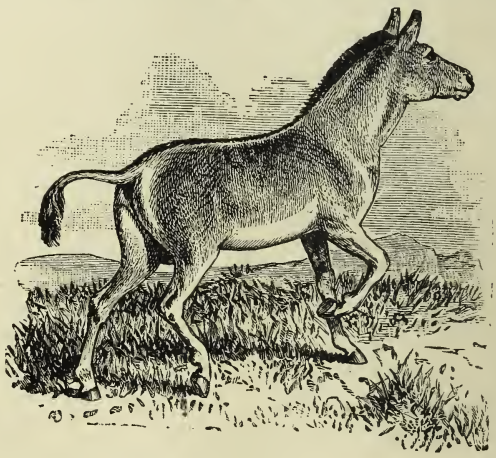
In both the Oxford and Cambridge schemes, single groups of subjects may be taken according to the choice or opportunities of the candidates. Thus at Cambridge there is a preliminary group including English language, history and literature, with arithmetic, which all must pass; and there are other groups of subjects, such as divinity, mathematics, languages, natural science, mental science, music, art, etc.

After the first group has been passed, it is possible to take up a single language at once, or a single subject of natural science, or more at pleasure.

Opportunity is given for showing higher attainments in all the subjects; and valuable scholarships are awarded to those who are specially distinguished, as also to younger students who do well in the Senior Local examinations, which are limited to those under eighteen years of age.

Yet higher advantages are within the reach of those who can manage to spend one or more years in Oxford or Cambridge. The benefits of residence at the older universities have long been acknowledged as regards men, and they are no less for women. At Oxford, St. Mary Hall and Somerville Hall receive women students desirous of being educated there; and at Cambridge, Girton and Newnham Colleges are established for a similar purpose.

The following extracts from the Memorandum of Association of Newnham College sufficiently exemplify the character of these institutions: "To establish and maintain at or near Cambridge houses or residences in which women students may reside and study; to provide for the instruction of women students, and for the delivery of lectures to such students, or to other women at or near Cambridge; and the doing of such other things as are incidental or conducive to advancing education and learning among women in Cambridge and elsewhere."



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Residence in a university offers unique advantages: not only are the students receiving instruction from the ablest men of the age, but they are in constant association with other students who are kindred spirits, at any rate as regards their love of study. There is nothing to take the mind away from its object, but everything in intercourse, example and encouragement to lead a girl to succeed.

In addition to this, the social gain is important, for here girls from all ranks of educated society associate on equal terms, and the result of this is the refining of those who have not had early advantages in the usages of society.

Newnham College, of which alone we can find space for particulars, has two halls of residence closely adjacent, built to accommodate a principal, vice-principal, resident lady-lecturers, and about seventy students. Each student has one room arranged to combine the purposes of bedroom and study, and in each hall there are a library, a dining-room, and other rooms for the use of the students in common. There are also lecture-rooms, a chemical laboratory, and a gymnasium. The lectures for women, out of which this College has developed, were first started in January 1870, and the labours and advocacy of some of the best men and women in the University and elsewhere have been devoted to maturing the system by which the present most excellent result has been secured, so that all opposition and prejudice have been overcome, and women students can now compete in the honours examinations of the University, though not as yet for the money prizes and emoluments.

It is found that students derive greater advantage from spending their time at Oxford or Cambridge in advanced than in elementary work; and it is much to be recommended that any who are hoping to go to Cambridge will pass their elementary examinations first, for they can thereby be exempted from the University Previous Examination or "Little Go," and commence at once to prepare for the advanced or honours examinations, which require a course varying from three to four years.

The examinations by which this exemption can be obtained are certain portions of the Senior Local and the Higher Local, and the Oxford and Cambridge joint examinations; information about these can always be obtained of the Secretaries.

By the Cambridge Triposes are meant those examinations by which the B.A. degree is obtained *with honors*.

The titles of the principal Triposes are the Mathematical, the Classical, the Law, the Natural Science, the Moral Science, the Historical, and the Theological. Plans of study are set forth in each of these departments of learning, involving at least three years' work for a sound and healthy brain already well trained by a previous education. Usually a portion of the subjects is indicated as elementary and necessary, and the first part of the examination is separated from the rest; upon this it is determined whether candidates shall be permitted to enter the second part. Candidates are arranged in three classes of honours, and a place in the first class is intended to certify that the student has shown industry and good ability, and a real power of thought and grasp of the subjects. The names of female students who have passed each tripos examination are placed in a separate list according to the same standard as the men; and in cases where the first class is arranged in order of merit, the place of each female student is given according as it would have been placed in the list of the men.

However, the formal degree is not yet granted to women at Oxford and Cambridge, but no doubt for this there is a good time coming.

ZOOLOGY.

XXXI.

Order Ungulata; Hoofed Quadrupeds.

The easily recognizable character of the possession of hoofs unites animals as diverse as the horse, the rhinoceros, the hippopotamus, the camel, and the ox. All of them have teeth of more than one kind, in two sets, and their grinding teeth are not sharp, scissor-like blades, but broad, marked with ridges or knobs in special patterns. They have no collar bones, and are not adapted for climbing; and none of them have more than four digits on each limb. The bones corresponding to those of the human hand and foot do not rest upon the ground, and except the extremities of the digit, no part of them usually touches the ground. The middle bones are mostly lengthened and almost vertical in position. The ends of the digits are enabled to support the weight of the body by the growth of horny sheaths which we call hoofs, which are really so many huge nails clothing and protecting the bone. In all, the large brain or cerebrum does not extend backwards far over the small brain or cerebellum.

General character.

ZEBRA. HARTE-BEESTE.

The Odd-toed Ungulates.

The most satisfactory division of this great group is that into odd- and even-toed, reckoning by the hind foot. The horse, as is well known, has but a single complete digit, while the ox has two. In the odd-toed section, the middle or third digit is largest, and when others are present, they are the second and fourth, the first being always lacking. With this feature we find associated an uncomplicated stomach, and a remarkable enlargement of the first part of the large intestine, called the blind gut. No horns growing upon a bony core occur in this section.

Odd and even-toed.

The Horse Family.

This family is the only group of mammals in which the effective digits are reduced to a single one for each limb. Rudiments of two others remain, and in extinct horses these rudiments are found to be gradually larger as we go backwards in time, until a completely three-toed animal is reached. In the hoof of a horse merely the last bone of the middle finger or toe is enclosed, and the rest of the foot is almost upright. What is often called the "knee" of a horse really corresponds to our wrist, while the projection in the middle of the hind leg, called the "hock," is the true heel. The so-called "cannon-bone" answers to the middle long bone of our palm and sole, much lengthened and thickened. On either side of the cannon-bone is a small "splint bone" representing the long bones of the second and fourth digits. The enveloping of the last bone of the digit in a thick horny hoof enables it to bear the weight of the animal well, and to undergo the sudden concussion which occurs in running; while the positions of the arm and thigh-bones, the first passing obliquely forwards, and the latter obliquely backwards, and scarcely distinguishable from outside, give the most spring-like arrangement for rapid and safe action.

Peculiarities of limbs.

The skull is much elongated, and contains a posterior part, in which the little brain lies, not covered by the cerebrum. The snout is long, and the eyes, placed rather far back, are entirely engirt by bone. The back part of the lower jaw is deep, and gives rise to powerful grinding muscles. The teeth constitute a striking and important feature; the large grinders have patterns, produced by the alternation of enamel, dentine, and cement or tooth-bone, which are gradually worn away by use, leaving an uneven surface always exposed. The total number of permanent teeth is forty, including six grinders on each side. Each of the incisor teeth has a deep inner fold of enamel, the latter forming an encircling ridge round the pit, which is filled up with compressed food. The ridge gradually wears away, forming a "mark" of differing shape at different ages up to about eight years old, when the mark has entirely disappeared on all the teeth.

Skull.

Teeth.

The "mark."

All existing horses can be included in one species—even the wild horses of Tartary, South America, and Australia. It is not considered

probable that any known kind of horse represents the original wild horse; for man has so long kept horses as domestic servants, and it is so certain that the wild horses in many regions are the descendants of runaways from man, that all the living forms may be regarded as having been influenced more or less thoroughly by human selection and training. Wherever food is scanty or the country is mountainous, the horses are small, and are called ponies. They can exist in regions of almost perpetual snow or in the tropics, and thus being hardy, variable, and strong, are calculated to render the most valuable services to man. The more primitive kinds of horses appear to be dun-coloured, and to have had a dark stripe down the back, allying them with the ass and zebra.

Human selection.

Horses are bred for use in war, for agricultural and draught purposes, and for speed. In the Bible there are many fine passages referring to the war-horse, and the records of Egypt show their employment for drawing chariots. Cavalry was of later introduction, partly because of the heavy expense of keeping the horses; but when this difficulty was surmounted, owing to the increased wealth of nations, cavalry became of great importance in war, and remained of very high value until the increased range of rifles somewhat diminished their employment, except for reconnoitring purposes.

The war-horse.

To successive kings of England from an early period we are indebted for continual improvements in our domestic breeds. King John may be allowed some credit in this direction, if for little else. Germany, the Low Countries, and Spain in turn contributed new blood; and finally the introduction of an Arab horse early in last century was the starting point of the modern race of English thorough-bred, which ranks highest in the world for speed as well as beauty. The trotting-horse has become very characteristic of the United States, but is descended in the main from the same stock as the English racer. The dray-horse is as much a product of special breeding for power in slow movement as the race-horse for speed. Another well-known peculiar form of horse is the lively little Shetland pony with its long shaggy mane.

Royal influence.

Every one has heard of the attachment between the Arab and his steed, so often displayed in a reluctance to part with one to strangers under the temptation of much money, when money was urgently needed. The Arab feeds and trains his desert companion with great care in youth, and finds his advantage in the endurance of which he is capable when adult. The Barb is an almost equally famous breed, whose home is the north of Africa. The absence of native horses in America and in Australia is a fact well worth pondering as an instance of special geographical distribution, in conjunction with the occurrence of ancient species of horses in America in former geological epochs of comparatively modern date. It is strange, indeed, to witness the disturbance which human agency makes in the spread of animals. For long ages horses are non-existent in South America; the continent is discovered by men from the Old World, who soon transport some domestic horses thither; now and again a horse runs from home, and, finding the climate and food suitable, the wanderers become wild, and before long multiply exceedingly, so as to range the country in vast herds. If we contemplate further the changes consequent on the food requirements of these horses,—for what one animal eats cannot be eaten by another; the parasitic creatures, internal and external, which feed upon such a large animal as the horse; the multitude of smaller existences that are trampled out in the scampering and galloping of the horse-troops—we realise faintly the potent and far-reaching influences which are ever at work to modify and transform the aspect and relations of animate beings.

The Arab and other breeds.

Wild horses in New World.

The asses, zebras, and quaggas are the remaining living members of the family, characterised, especially the latter two, by their striped markings, which are, indeed, nearly always present in asses to some extent. The dark spinal stripe is most constant in the ass; the handsome and intractable zebra of South Africa has very numerous alternate black and white bands of colour nearly all over the body, even covering the legs with broad horizontal bars. The quagga, ranging over the district south of the river Vaal, has less numerous and less conspicuous markings. Four species of wild asses are recognized, but it is agreed that the Abyssinian ass is the parent of our domestic breed. The comparative insignificance into which the ass has fallen in our country is not a sign that the creature is markedly less variable or worthy of careful breeding than the horse; but the superior size and strength of the latter probably gave him a start in the race of improvement, which has ever since given him the preference in the eyes of breeders. Very good results have been attained in the breeding of asses in the East, where they are and have long been highly regarded. Mules are a cross between the ass and the mare, and constitute a valuable representative of a hybrid or intermediate between two distinct species.

Zebras and quaggas.

The domestic ass.

HOW TO ENTER THE CIVIL SERVICE.

II.

HAVING given the General Regulations under which competitive examinations for Civil Service clerkships are held, we now proceed to the Special Regulations as they at present exist, giving only the necessary caution that they are liable to alteration from time to time.

Higher Division and New Higher Division Clerkships.

No candidate is admitted to the competition for these situations under the age of eighteen, or beyond the age of twenty-four; and, as previously explained, all candidates must pass a preliminary examination to the satisfaction of the Commissioners in the following subjects :—

1. Handwriting.
2. Orthography.
3. Arithmetic (to vulgar and decimal fractions).
4. English Composition.

At the competitive examinations exercises are set in the following subjects only; the maximum of marks for each subject being fixed as follows; viz. :—

	Marks.
English Composition (including Précis writing)	500
History of England (including that of the Laws and Constitution)	500
English Language and Literature	500
Language, Literature, and History of—	
Greece	750
Rome	750
France	375
Germany	375
Italy	375
Mathematics (pure and mixed)	1,250
Natural Science: that is, (1) Chemistry, including Heat; (2) Electricity and Magnetism; (3) Geology and Mineralogy; (4) Zoology; (5) Botany (The total (1,000) marks may be obtained by adequate proficiency in any two or more of the five branches of science included under this head.)	1,000
Moral Sciences: that is, Logic, Mental and Moral Philosophy	500
Jurisprudence	375
Political Economy	375

Candidates will be at liberty to offer themselves for examination in any or all of these subjects. No subjects are obligatory.

No candidate will be allowed any marks in respect of any subject of examination unless he shall be considered to possess a *competent knowledge* of that subject.

The fee for the preliminary examination is £1, and a further fee of £5 is required of every candidate admitted to the competition.

Out of the list resulting from each competitive examination will be filled (provided there be candidates duly qualified) :—

(*a*) All the vacancies in Class I. which may have been reported to the Civil Service Commissioners up to the date at which the notice of the examination is published in the *London Gazette*.

(*b*) Such other vacancies (being in the "New Higher Division of the Civil Service") as the Civil Service Commissioners, with the approval of the Lords of the Treasury, shall estimate as likely to occur within six months after the date of the said notice.

(*c*) Any vacancy in Class I. (but not in the "New Higher Division") occurring within six months from the said date, which the head of the department may desire to have so filled.

Candidates will be allowed to choose, according to their place on the list, among the vacancies (*a*) for which they are duly qualified; or they may elect to wait for a vacancy (*b*) or for the chance of a vacancy (*c*). When vacancies (*b*) or (*c*) occur, they will be offered in rotation to the qualified candidates then on the list, who will be free to decline them without forfeiting their claim to subsequent vacancies (*b*) or (*c*).

By the term "New Higher Division of the Civil Service" is meant situations to be filled under the above Regulations, with salaries commencing at £100, and rising by triennial increments to £400, to which may be added, at any stage, in the case of persons selected for the performance of special duties, duty pay of proportionate amount not exceeding £200.

Specimens of examination papers used in these competitions may be obtained through the booksellers; and intending candidates should bear in mind especially that quality rather than quantity is taken into account by the examiners, that no one is required to undertake all the subjects contained in the list given, and that unless competent knowledge is shownby a candidate in a subject, he will get no marks at all for his work in connection with it.

After a candidate has successfully passed his examination and received his appointment, he enters on a six months' probation, during which his ability will be put to a practical test under the supervision of the head of his department, and he will not be finally appointed to the public service unless during that period he gives satisfactory proof of his fitness for permanent employment.

The following list contains the names of the situations which, up to the present time, have been placed in Class I. Of these, those marked thus (‡) are in the "New Higher Division" :— ‡Admiralty; Clerk. ‡Chief Secretary's Office, Ireland; Clerk in the Veterinary Branch. Civil Service Commission; Clerk. Colonial Office; Clerk. Constabulary, Ireland; Clerk in the Inspector General's Office. ‡Customs; Clerk. Ecclesiastical Commission; Clerk. Home Office; Clerk. India Office; Clerk in the Correspondence Department. Inland Revenue; ‡Assistant Surveyor of Taxes, and ‡Clerk. ‡Lunacy Commission; Clerk. ‡Patent Office; Clerk. Post Office; Clerk in Secretary's Office (Grade I.). Record Office, England; Clerk. Record Office, Ireland; Clerk. ‡Science and Art Department; Clerk. Treasury; Clerk. ‡War Office; Clerk.

Lower Division Clerkships.

Competitive examinations for lower division clerkships are open to all natural-born subjects of Her Majesty, with the exceptions and restrictions as mentioned in the general regulations printed on page 707. Candidates must be over seventeen years of age, and under twenty, on the first day of the competitive examination.

A fee of 10*s.* will be required from every candidate attending a preliminary examination, and a further fee of 10*s.* from every candidate admitted to the competitive examination.

The subjects of examination will be as follows:—

1. Handwriting.
2. Orthography.
3. Arithmetic.
4. Copying MS. (to test accuracy)
5. English Composition.
6. Geography.
7. Indexing or Docketing.
8. Digesting Returns into Summaries.
9. English History.
10. Book-keeping.

No candidate can be admitted to the competition who has not previously satisfied the Civil Service Commissioners that he possesses the requisite amount of proficiency in handwriting, orthography, and arithmetic (including vulgar and decimal fractions). With this view, preliminary examinations in these subjects will be held at such times and places as the Commissioners may appoint. Application for permission to attend one of these preliminary examinations must be made in the writing of the candidate, at such times and in such manner as may be fixed by the Commissioners.

The number of persons to be selected at each examination will be published as part of the notice of every such examination. A list of the competitors will be made out, in the order of merit, up to this published number, if so many are found by the examination to be qualified.

Each competitor placed on the list for the Lower Division of the Civil Service will remain thereon until he attains the age of twenty-five years, unless in the meantime he has been appointed to a situation in some public office.

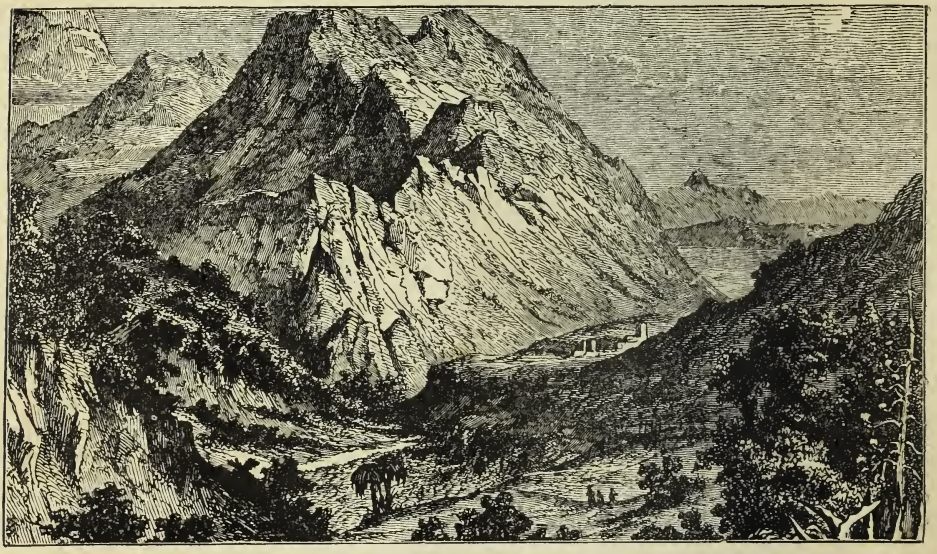
Candidates on completing their twenty-fifth year, or on receiving appointments, will be removed from the list.

From these lists the Civil Service Commissioners, on the application of departments having vacancies, will supply, on probation, the requisite clerks, whether for permanent or temporary duty. Selections will, as a general rule, be made by the Civil Service Commissioners according to the order of the names on the list; but the Civil Service Commissioners may select any clerk who, in his examination, has shown special qualifications in any particular subject, if special application for such a clerk be made by any department.

No clerk will remain more than one year in any department unless at the end of that time the head of the department shall signify in writing to the Civil Service Commissioners that the clerk is accepted by the department. If he is not accepted, the department will report to the said Commissioners the reasons for not accepting him; and such Commissioners will thereon supply another clerk in his room, and will decide whether the name of the rejected clerk shall be struck off the lists, as unfit for the service generally, or whether he shall be allowed a trial in another department.

Second-class clerkships in the India Office (salary, first year £80, second year £90, and afterwards £100, rising by triennial increments of £25 to £250) and second-class clerkships in the India Audit Office, (salary commencing at £80, and rising to £250) are filled by competition in the same manner, successful candidates being allowed their choice.

It is to be distinctly understood that clerks in the Lower Division may be transferred from one department to another at any time, as their services may be required. Specimens of examination papers, though not supplied by



AMONG THE PEAKS OF THE ANDES.

the Commissioners, can be obtained of booksellers, and should be carefully studied by intending candidates.

The following is a list of the departments to which Lower Division men clerks have been assigned:—

Admiralty; British Museum; Charitable Bequests Commission, Ireland; Charity Commission; Chief Secretary's Office, Ireland; Civil Service Commission; Colonial Office; Constabulary, Ireland, Inspector-General's Office; Copyhold, Inclosure, and Tithe Commission; Customs; Registry of Deeds, Ireland; Dublin Metropolitan Police (Commissioners' Office); Dublin Metropolitan Police (Divisional Offices); Education Department; Exchequer and Audit Office; Fisheries, Office of Inspectors of, Ireland; Friendly Societies Registry; Home Office; Inland Revenue; Local Government Board, England; Local Government Board, Ireland; Lunacy Commission; Mint; National Debt Office; National Education Office, Ireland; Patent Office; Paymaster-General's Office, including Chancery Pay Office; Post Office; Prisons Service, Ireland; Prisons Department, Scotland; Privy Council Office; Public Works Loan Office; Public Works Office, Ireland; Queen's and Lord Treasurer's Remembrancer's Office, Scotland; Reformatories' Office; Registrar-General's Office, England; Registrar-General's Office, Ireland; Registrar-General's Office, Scotland; Science and Art Department; Seamen's Registry Office; Stationery Office; Temporary Commissions; Trade, Board of; Trade Mark's Registry; Treasury; Valuation Office, Ireland; Veterinary Department; War Office (including Judge Advocate General's Office); Office of Woods (including Quit Rent Office, Dublin); Office of Works.

In our next article we shall speak of boy clerkships, included in the lower division of the Civil Service,

XVI.

SOUTH AMERICA.

SOUTH AMERICA is the southern portion of the New Continent of America, being connected with North America by the Isthmus of Panama, where narrowest, only about forty-eight miles across, and otherwise surrounded by the sea, so as to form a vast peninsula. It lies between lat. 12° 30′ N. and 55° S., and long. 34° 30′ and 82° W., and is bounded on the north by the Caribbean Sea, north-east and east by the Atlantic Ocean, south by the Antarctic Ocean, and west by the Pacific Ocean. Its length from north to south is 4,800, and its greatest breadth

ON THE AMAZON.

3,200 miles. Area about 7,000,000 square miles, and population 27,000,000. The entire length of coast-line is only about 16,000 miles. The vast mountain chain of the Andes stretches along the western coast from the Isthmus of Panama to Cape Horn. It is about 4,500 miles in length, with a breadth varying from 40 to 400 miles, and having as its highest summit Aconcagua, in Chili, 22,400 feet high. In general the slope is very steep towards the Pacific, the distance from which averages from 20 to 160 miles. The Patagonian and Chilian Andes consist of a single chain, which, further north, divides into stupendous ridges or cordilleras, enclosing between them the wide and lofty plateaux of Bolivia and Peru, more than 12,000 feet above the sea. Further north they form three distinct ranges, one of which runs north-east and extends along the coast of Venezuela; another proceeds north and terminates in Cape Gallinas; while the third passes north-west to form the Isthmus of Panama.

The interior of the country consists chiefly of three immense plains watered respectively by the Orinoco, Amazon, and Parana. The first of these, the llanos of the Orinoco, are flat, grassy plains, occupying about 150,000 square miles. The silvas of the Amazon, as their name indicates, are densely wooded, and are 1500 miles in length, by from 300 to 800 in breadth. The pampas of the Argentine country are treeless, grassy plains, having an area of 300,000 square miles. Besides these there is the desert of Patagonia, nearly 200,000 square miles in extent. Eastward the country again rises, and in Brazil are several mountain chains, running north-east and south-west, which attain a height of 8000 or 9000 feet. All the most important rivers of South America fall into the Atlantic. The largest of these is the Amazon, which rises in the table-land of Pasco, in Peru, flows eastward through nearly the entire breadth of the continent, and, after a course of about 4000 miles, in which it receives many important tributaries, falls into the Atlantic by a broad estuary. It is navigable for 2200 miles from its mouth. The next in size is the Parana, which rises in the mountains of Brazil, flows southward, receiving the Paraguay and other large streams, and afterwards uniting with the Uruguay to form the Rio de la Plata. Its length is about 2200 miles. Next, though much inferior to these, is the Orinoco, in the north, which rises in the Sierra del Parima, traverses Venezuela, and falls into the Atlantic Ocean by many mouths, after a course of about 1400 miles. It has numerous tributaries, and by means of the Cassiquiari has a natural communication with the Rio Negro, an affluent of the Amazon. The principal of the other rivers are the Magdalena, Essequibo, Socantins, San Francisco, Colorado, and Negro. The chief lakes are—Lake Maracaybo, in Venezuela, having an area of 5,000 square miles, and communicating with the sea by a narrow channel; Lake dos Patos, in the south-east of Brazil, 5000 square miles in area, and discharging its waters into the Atlantic; and Lake Titicaca, on the confines of Peru and Bolivia, 4000 square miles in area, and 12,550 feet above the sea.

About two-thirds of the area of this continent is situated within the tropics, and consequently the climate is very hot, although not so hot as its geographical position would indicate, being tempered by the cool trade winds from the east. The hottest district is in the north of Venezuela, where the average annual temperature is 81°. The climate of Brazil and the adjoining countries is comparatively mild and temperate, the mean annual temperature at Rio de Janeiro being 74°. In the south the climate becomes very severe, and the western shores are considerably colder than the eastern. On the east coast between the tropics the rainfall is very considerable, being in some parts of Brazil as much sometimes as 260 inches in twelve months. On the west coast, on the other hand, there is a large tract in Upper Chili and Peru where no rain falls. The vegetation in those parts between the tropics where rain is abundant is most luxuriant. Probably in no other part of the globe does it appear in such profusion and variety. Immense forests of gigantic trees, with flowers of great brilliancy, occupy most of this region. Fruit trees and plants also abound, including the cocoa-nut, orange, cocoa, pomegranate, tamarind, mango, plantain, pine-apple, banana, etc. The cinchona tree and quassia plant also occur. Maize, the sugar-cane, coffee, cotton, tobacco, indigo, etc., are cultivated. The jaguar and puma are the most formidable beasts of prey. The principal native domesticated animals are the llamas and pacos, but horses, oxen, sheep, etc., have been introduced from Europe and are now common. Monkeys and apes abound in the forests, and snakes are common. Of birds, the condor, a species of vulture of great size, is the most remarkable. Among others are eagles, vultures, falcons, parrots, humming birds, etc., many of them having very beautiful plumage. Silver is the most important mineral product, but gold and other metals are also found, and in Chili copper is very abundant. Tin, lead, mercury, iron, antimony, are also found, and diamonds and other precious stones are obtained in Brazil.

The following are the principal states :—

COLOMBIA, THE UNITED STATES OF, formerly New Granada, occupies the north-western portion of the continent, including the Isthmus of Panama. It is bounded on the north by the Caribbean Sea, on the east by Venezuela and Brazil, on the south by Ecuador, and on the west by the Pacific. Area, 318,250 square miles. The country is traversed from south to north by three great ranges of the Andes, the central range having the peak of Tolima, over 18,000 feet in height. Between the central and eastern ranges is the valley of the Magdalena, the chief river of the country; and between the central and western ranges that of the Cauca, a tributary of the former. A ship canal to connect the Atlantic and Pacific Oceans is in course of construction across the Isthmus of Panama. The forests are extensive, including mahogany, cedar, and other trees; and the agricultural products are maize, wheat, rice, sugar, coffee, cotton, tobacco. The mineral productions are gold, silver, platinum, copper, iron, lead, coal, and precious stones. The chief exports are the precious metals, tobacco, coffee, hides, and cotton. Colombia is a confederation of nine states, viz., Panama, Cauca, Antioquia, Bolivar, Magdalena, Santander, Boyaca, Cundinamarca, and Tolima. The executive is vested in a President, the legislative in a Senate and a House of Representatives; the former composed of three members for each state, the latter of one representative for every 50,000 of the population, which is about 3,000,000.

VENEZUELA is bounded north by the Caribbean Sea, east by Guiana, south by Brazil, and west by Colombia. Area, 440,000 square miles. The northern and southern portions of the country are mountainous, while the central portion belongs to the great basin of the Orinoco. The vegetation is extremely rich and varied. The staple productions are coffee,

cocoa, indigo, sugar, cotton, tobacco. The inhabitants are chiefly employed in agriculture, or in the rearing of horses, cattle, and sheep, of which there are immense numbers. The most important mineral product is copper. The form of government is republican, with a President and a Federal Council. Population, 2,070,497.

GUIANA extends eastward from Venezuela, and has on the north the Atlantic, and south Brazil. It is divided into British, Dutch, and French Guiana. British Guiana comprises the western part of the country, and has an area of 85,000 square miles, and 252,000 inhabitants. The chief product is sugar. The districts are Demerara, Essequibo, and Berbice. Dutch Guiana occupies the centre of the country, and has an area of 46,100 square miles, and 68,500 inhabitants. French Guiana, which forms the eastern part, has an area of 46,900 square miles, and 27,299 inhabitants.

ECUADOR lies immediately south of Colombia and stretches from the Pacific eastward across the Andes to the valley of the Amazon, having Brazil on the east and Peru on the south. Area, 248,000 square miles. The Andes here rise to the height of 20,000 feet, Mount Chimborazo being 20,700 feet above the sea. The portion of the country lying within the valley of the Amazon is richly wooded. The principal products are cocoa, coffee, cinchona and cascarilla bark, vegetable ivory, caoutchouc, wheat, cotton, tobacco. Gold, silver, lead, iron, and copper are found. The government is republican, with a President and a Council. Population, 1,146,000.

BRAZIL, the most extensive state of South America, embracing not much less than half the continent, and approaching in size to the whole of Europe, extends along the Atlantic from Guiana to Uruguay, and touches on every other state except Chili. It has a coast line of about 4,000 miles, measures in a direct line from east to west 2,600, and from north to south 2,450 miles, and has an area of 3,218,000 square miles. The northern and western portion of the territory is flat, belonging to the basin of the Amazon, while the eastern portion is traversed by several parallel mountain ranges running from south-west to north-east, and attaining a height of 8000 or 9000 feet. The climate in the low country is characterised by great heat and moisture, while on the higher lands the temperature is lower and the fall of rain much less. The forests are of great extent and luxuriance, furnishing every variety of useful and beautiful timber, mahogany, rosewood, brazil-wood, logwood, etc. On the higher lands European grains and fruits are raised in abundance. The principal products are maize, wheat, rice, beans, cocoa, cassava plant, sugar, coffee, cotton, tobacco, caoutchouc, cinchona, Paraguay tea. The mineral wealth is considerable, including gold, silver, iron, diamonds, topazes, and other precious stones. Many of the inhabitants are employed in agriculture and the rearing of cattle. Population, 10,108,291, of whom 1,510,806 are slaves. The government is an hereditary constitutional monarchy, with a Senate of 58 members elected for life, and a Chamber of 122 deputies chosen by the free population for four years. The capital is Rio de Janeiro, with 228,000 inhabitants. In 1880 the imports from the United Kingdom amounted to £6,915,000, and the exports to the United Kingdom to £526,000. There are 1800 miles of railway in operation.

XLVI.

ROME (*continued*).

AFTER the death of Caius Gracchus, the nobles regained for a time their old power. The late reforms were reversed, or, at all events, practically ignored, and nothing further was done towards admitting the Italians to the franchise. A few years later a new and formidable enemy threatened Rome. Hordes of barbarians, known as Cimbri and Teutones (Germans), came pouring down upon the Alps and threatened to cross into northern Italy. Roman armies were sent to drive them back, but in two years the barbarians four times defeated and crushed the Romans with fearful slaughter. Meantime fresh troubles in Africa called for Roman legions there. Jugurtha, having driven out his brothers, had made himself sole ruler of Numidia, a country bordering on Carthage. The Romans interfered, and commanded Jugurtha to come to Rome to be tried for his misconduct. But having bribed his judges he got off, and was allowed to return to Numidia; exclaiming as he left Rome, "O venal city! you would sell yourself if you could only find a purchaser." War was soon after declared against him, but he bribed the generals, and nothing was done against him, until at last a Roman was found who would not take bribes. This was Metellus. Jugurtha was now hard pressed, and Metellus had almost finished the war when he was superseded by his lieutenant Caius Marius. This Caius Marius was a remarkable man, and played a remarkable part in the history of Rome. He is said to have begun life as a farm labourer, passing from that into the army as a common soldier under Scipio. From this famous general he learnt the art of war and habits of strict discipline, and soon got promotion in the army. But he was ambitious of political power as well as of military rank. So he became a candidate for the tribuneship, and was elected, the people taking a great liking to him. He went with the consul Metellus to carry on the war against Jugurtha, and in a short time returned to Rome to seek the consulship. His popularity was so great that the people not only elected him to the consulship, but forced the senate to send him to Africa in place of his late commander, Metellus. Recruiting an army from the lowest rabble of Rome, who

Incursions of the Cimbri and Teutones.

Troubles in Africa.

Caius Marius.

had no stake in the country, and were devoted only to their leader. he proceeded to Africa, where he determined to kill or capture Jugurtha. Driven into the desert, and betrayed by his allies, Jugurtha was at last taken prisoner and brought in chains to Rome. For two years he was kept alive that he might be paraded in the triumphal processions of the Roman generals, and he was then allowed to perish miserably in an underground dungeon from starvation.

Marius captures Jugurtha.

Marius returned to Rome in B.C. 104, and found he had been again elected consul in his absence. And now it was decided to send him against the Cimbri and Teutones, who were again threatening the north of Italy, and had defeated all the armies hitherto sent against them. In two savage battles Marius defeated the Teutones, and almost destroyed their whole force. A great deal of spoil fell into his hands, most of which he burned in a great pile. Just as he was lighting it, a horseman from Rome dashed up with the news that Marius was now for the fifth time elected consul, —an honour never before conferred on any Roman, and, indeed, contrary to the spirit of the old constitution. It is said that the anniversary of this event is kept up at the present day at the same place, the villagers lighting a great bonfire on a certain hill, and shouting "Victoire! Victoire!" Then he marched against the other invaders, the Cimbri, who, crossing into Italy by the Brenner Pass in the Tyrol, had defeated the raw levies of his colleague Catullus. The veterans of Marius routed and destroyed these also; and Marius returned in triumph to Rome, where he was hailed as its deliverer. So great was the alarm excited by the early successes of the invaders that the Romans called Marius the third founder of Rome, the other two being Romulus the original founder, and Camillus who drove out the Gauls. But Marius was a very different man from Camillus. His objects were low and selfish, and though a great soldier he was no statesman, and had but little patriotism. Riots and troubles occurred in Rome, and he took no pains to set things right, but first helped one party and then the other according as it suited his purposes. The great question of the day was whether the Italians should be admitted to the citizenship. A considerable party at Rome wished to admit them, but the majority opposed it. Riots occurred, and at last the Italians, seeing no hope of gaining their ends peacefully, broke out into open war. The Romans had to give way after three years' fighting, in which, according to their historians, victory was always on their side. The struggle was undoubtedly a fierce one, and fortunately for the future of Rome she was obliged to yield to the demands of the Italians and extend the franchise to them. The precedent created was acted upon several times afterwards in the case of the Spaniards, Gauls, and others.

Marius defeats the Teutones and Cimbri.

The Social War.

P. CORNELIUS SCIPIO.

The war was called the "Social War," or war against the allies (Lat. *socii* = allies). Marius having lost some of his popularity, was not given any important post in this war. His former lieutenant, Sulla, was the general most trusted, and at the end of the war was chosen consul, and being backed by the nobles, became a dangerous rival to Marius. Sulla was ordered to proceed with a powerful army to Asia Minor to avenge a tremendous massacre of Italians, to the number of about a hundred thousand, by Mithridates, king of Pontus. Marius wished to command the expedition in Sulla's place, and when disappointed by the senate, he stirred up a riot in the city after Sulla's departure, and got himself appointed in Sulla's stead. But Sulla had not yet left Italy, and turning back suddenly on Rome, Marius was obliged to fly, and Sulla, by an arbitrary decree, not only took away the newly-acquired privileges of the Italians, but even had the audacity to annul the long-standing right of the people to pass laws in their assembly. Having thus, as he thought, made the senate and the aristocratic party supreme over Marius and the Italian party, he, in an evil day for Rome, set out with his legions for the east. Meanwhile Marius was flying for his life from place to place, and once was captured and actually condemned to death, but the slave who was sent to execute him in prison was so terrified by the old man's glance that he fled away dismayed, and the magistrates thought it better to let their formidable prisoner escape.

Sulla.

Marius driven out by Sulla.

Changes in the constitution.

After this he went to Africa, and was found sitting among the ruins of Carthage. But in Sulla's absence the consuls at Rome began to quarrel, one being for Marius, the other for Sulla. Cinna, the consul who favoured Marius, was driven from the city; but he soon collected an army in the country, and Marius having landed on the coast of Italy, gathered another band of run-

Parties at Rome.

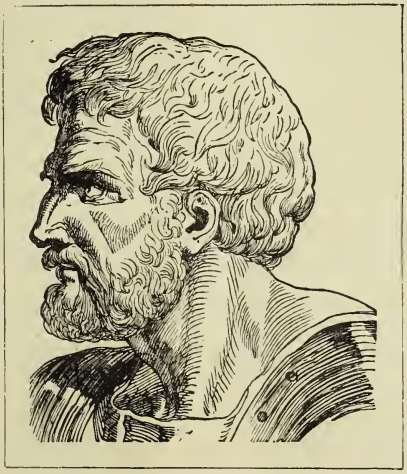
away slaves and desperadoes, with which he marched on Rome, while Cinna advanced towards the same place from the south. In fact, Rome was now menaced by no less than four armies of her own rebellious citizens, while some of the Italian allies were also in arms against her and thirsting for revenge. The senate could make no defence.

Return of Marius. Cinna and Marius marched into Rome as conquerors; the other consul was put to death, and a general massacre took place. The friends of

Massacres. Sulla and the aristocratic party, including many of the best and most eminent senators, as well as hundreds of humbler citizens, were slaughtered by command of Marius, who went through the city with a band of followers pointing out his victims. Marius got himself nominated for the seventh time as consul, but soon after

Death of Marius. died quietly in his bed at the age of seventy (B.C. 86), after "sounding all the depths and shoals of fortune." Sulla was still absent in the

Return of Sulla. east, but two years later, having made peace with Mithridates, he returned to Italy. At first, his army being not large enough to meet the consuls, he did not venture to march on Rome, but remained in the south strengthening himself and preparing for a future struggle. Then, when he felt strong enough, he marched north, and fought a great battle outside Rome, just in time to prevent the destruction of the city, which the other party had in despair decided upon; eight thousand prisoners were taken, and the next day massacred by his soldiers.



CAIUS MARIUS.

Proscriptions. This was only the beginning of Sulla's massacres. The cruelties of Marius were outdone by his rival. All who had favoured Marius were hunted up and mercilessly put to death. Lists were made out every day of persons whom any one might kill, and rewards were offered for their heads. The favourites of Sulla, for a small bribe, used to put on these lists the names of any man's private enemies. The same thing went on all through Italy. Once Sulla was asked in the senate if he had yet slain victims enough. He pulled out a new list of eighty names. Next day he had two hundred and thirty names, and a few days later as many more. "By-and-by I may remember more," was his remark. In these "proscriptions," as they were called, nearly two hundred senators, between two and three thousand knights, and many thousands of the common people perished. Julius Cæsar, at that time only eighteen years of age, had a narrow escape. His wife was a relative of Cinna, and he was ordered to put her away. He refused, and fled from Rome,

Escape of Julius Cæsar. followed by his would-be assassins. But his friends managed to make interest for him; and Sulla consented to let him go, remarking prophetically, "There is more than one Marius in that young trifler!"

State of Italy. The fearful state of Italy and the provinces in consequence of these massacres is thus described by Merivale:—"The Apennines, from north to south, were infested with hordes of ruined fugitives, who had no resource left but robbery and violence. Property was insecure under the very walls of populous cities; and even free citizens were liable at any moment to be kidnapped and sold into slavery. Such was the ghastly state to which the civilized empire of the Romans had been reduced by anarchy and violence."

Sulla now set to work to establish a government and constitution according to his own ideas. The better to be able to carry out his own plans, he got himself declared dictator, not as in the old times, for six months, but for as long as he should think fit. He reconstituted the senate, and restored to it many of the exclusive rights which it had lost in the old struggles with the plebeians. The tribunes, on the other hand, and the popular assemblies, were deprived of most of their hard-earned privileges. Then at the height of his power he resigned his office, and retired into private life at his suburban villa, and died next year (B.C. 78), at the age of sixty. His reactionary legislation fell to pieces rapidly after his death. It was entirely against the spirit of the time and the natural development of events. As a ruler he was tyrannical and cruel; as a legislator he failed utterly; but as a general he saved Rome from possible overthrow by the powers of Asia Minor

"The system of Sulla, says a well-informed and discriminating writer, "was the greatest disaster in the annals of Rome His aim was to out-do all the popular measures of the last half-century; to check the progress of agrarian distributions; to suspend the plantation of colonies; to thwart, if he could not abrogate, the late enactments for the enfranchisement of the Italians; to destroy the popular authority of the tribunes, and to repel the knights from the judicia."

After the death of Sulla the senate hoped they would be able to manage the empire and keep their generals under control. The hope was a vain one, as we shall see

LI.

Irregular Verbs in the Foregoing Study,

(*see* p. 710.)

With their Present, Imperfect, Perfect Tenses, and Past Participles, to be noted for future use and committed to memory.

Ausfahren, to drive out (like the English to *fare* forth—the wayfarer): Indic. pres., Ich fahre aus, I drive out; imperf., Ich fuhr aus, I drove out; perfect ind., Ich bin ausgefahren, I *have* driven out; past participle, ausgefahren.

Ausreiten, to ride out: Ich reite aus, ich ritt aus, ich bin ausgeritten, ausgeritten.

(N.B.—The perfect is given where the verb seyn is used in the compound tense instead of haben, or in reflective verbs; it is unnecessary to give it where it corresponds with the English *to have* and the past participle.)

Scheinen, to appear or seem: Ich ſcheine, ich ſchien, geſchienen.

Halten, to hold: Ich halte, ich hielt, gehalten.

Sich aufhalten, to tarry, to reside: Ich halte mich auf, ich hielt mich auf, ich habe mich aufgehalten, aufgehalten.

Gehen, to go: Ich gehe, ich ging, ich bin gegangen, gegangen.

Kommen, to come: Ich komme, ich kam, ich bin gekommen, gekommen.

Aussehen, to look, appear: Ich ſehe aus, ich ſah aus, ausgeſehen.

Aufsteigen, to mount: Ich ſteige auf, ich ſtieg auf, ich bin aufgeſtiegen, aufgeſtiegen.

Stehen, to stand: Ich ſtehe, ich ſtand, ich bin geſtanden, geſtanden.

Remarks on the Foregoing Study.

[1] *Das Alter* has the meaning of age generally; *das Mannes-alter, das Jünglings-alter*, manhood, youth; and secondly, of old age.

[2] *Stets* has the meaning of steadily, like *stät*, steady: *Aber das Glück blieb ihm nicht stät*, but fortune did not remain steady (constant) to him (Schiller's *Wallenstein*). The reverse *unstät* is unsteady or unstable: *Unstät irren die Gedanken*, unsteadily the thoughts wander (Schiller's *Würde der Frauen*).

[3] *Aufhalten*, as a transitive verb, means to detain. *Halten Sie mich jetzt nicht auf*, do not detain me now. *Sich aufhalten*, to make a stay, to detain oneself.

[4] *Pomp.* This word is not really German, but is one of those numerous expressions introduced into the German from the French. In general, these words are avoided by good authors, who prefer words of German origin. The true German word for pomp is *Prunk*.

[5] *Das Glied* is originally the limb: *Die Arme und die Beine sind Glieder des Körpers*, the arms and the legs are limbs of the body. *In Reih und Glied*, said of soldiers, means in rank and file. *Ein zergliederter Körper*, a dismembered body.

[6] *Versorgungsposten* (from *sorgen*, to care); *versorgen*, to provide for or care for; thus *Versorgungsposten*, a post or office that forms a provision for any one.

[7] *Weg* has various meanings—originally *way*. It also signifies distance: *Er hat einen weiten Weg zu machen*, he has a long way to go; and sometimes an errand or a journey. Hence *der Wegweiser*, the sign-post (literally the way-shower).

[8] The *ent* in *wöchentlich* is inserted for the sake of euphony; *wöchlich* would be awkward to pronounce. We have also *stündlich*, hourly: *täglich*, daily; *monatlich*, monthly; *jährlich*, yearly; *augenblicklich*, momentarily.

[9] *Acht spännig. Spännig* is here used as derived from *spannen*, to fasten or yoke together. Thus we have—*die Pferde anspannen*, to put the horses to; *ausspannen*, to take them out or unyoke them. *Ein zweispänniger, ein vierspänniger Wagen*, a two-horse, a four-horse carriage.

[10] *Schirren*, to harness; *das Geschirr* is used for many kinds of apparatus—harness for horses; *das Tischgeschirr*, the service for the table; *Töpfergeschirr*, pottery.

[11] *Damalig*, belonging to that time. We also find *die diesmalige Frage*, the present question.

[12] *Der Aufschlag*, the border: *Mit blau aufgeschlagen*, turned up with blue.

[13] *Eingefasst* (from *einfassen*, to enclose, surround, or encircle). *Ein Bild in einem schönen Rahmen eingefaszt*, a picture set in a handsome frame.

[14] *Der Bediente* or *der Diener*, the servant (*Ich dien*). Thus *der Bedienten-tritt*, the step of the servants. *Tritt*, from *treten*, to tread; *zertreten*, to tread to pieces.

[15] *Der Stallknecht*, literally the stable-servant. From *der Knecht* comes the English "knight," originally from *Waffenknecht*, the servant-at-arms.

[16] *Die Ehrfurcht*, respect or reverence, literally the *fear* arising from the *honour* in which a person is held.

On the Irregular Verbs, their Classification, etc.

Those verbs are irregular in German that are not conjugated like lieben, to love; in which the root of the verb undergoes some alterations in the imperfect and past participle—as kennen, to know, kannte, gekannt; wiſſen, to know, wußte, gewußt; or in which the imperfect does not end in te and the past participle in t. The first division, those in which the irregularity is in the root, while the termination remains regular, are few in number. They are the following:

Infinitive.	*Imperfect.*	*Participle.*
Brennen, to burn	brannte	gebrannt
Bringen, to bring	brachte	gebracht
Denken, to think	dachte	gedacht
Kennen, to know	kannte	gekannt
Nennen, to name	nannte	genannt
Rennen, to run	rannte	gerannt
Senden, to send	ſandte	geſandt
Wenden, to turn	wandte	gewandt
Wiſſen, to know	wußte	gewußt

The only irregularity in the above-mentioned verbs is in the radical vowel—the tenses are formed in the usual way. For instance, Ich habe gerannt, I have run; Ich werde ſenden, I shall send; Er würde gewußt haben, he would have known, etc. Observe the t in the imperfect wandte, and the ß in wußte. Wiſſen is, moreover, irregular in the present: Ich weiß, I know; Du weißt (contraction of weißeſt), thou knowest; Er weiß, he knows; Wir wiſſen, we know, etc. (There be fools alive, I *wis*.—Shakespeare.)

The second class of irregular verbs comprises about a hundred and eighty; and in these the irregularity is in the termination. The imperfect, instead of ending in te, terminates variously; and the past participle ends

in en; for instance, ſehen, Ich ſah, geſehen, to see, I saw, seen. These verbs are sometimes subdivided into three sections.

The first section comprises those that have the same vowel in the infinitive and past participle, changing it only in the imperfect—such as halten, to hold, imperf. hielt, past part. gehalten; leſen, to read, imp. las, past part. geleſen; kommen, to come, imp. kam, past part. gekommen.

The second section includes those that have the same vowel in the imperfect and the past participle, and a different vowel in the infinitive—as heben, to lift, imp. ich hob, past part. gehoben; fliehen, to flee, ich floh, geflohen; gießen, to pour, ich goß, gegoſſen; fechten, to fight, ich focht, gefochten.

The third section comprises those verbs that have a different vowel in each of the three—the infinitive, imperfect, and past participle—as helfen, ich half, geholfen (the old English form "he hath holpen"), to help; nehmen, ich nahm, genommen, to take; bergen, ich barg, geborgen, to hide; ſterben, ich ſtarb, geſtorben, to die; binden, ich band, gebunden, to bind, etc.

In conjugating irregular verbs, it is only necessary to remember the departure from the rule in the imperfect and past participle, and in some cases in the first and second person of the present; the tenses are conjugated in the ordinary way with haben, and in a few cases with ſeyn. For instance, the verb nehmen, nahm, genommen, to take, and werfen, warf, geworfen, to throw, are thus conjugated.

INDICATIVE.	SUBJUNCTIVE.
Present.	
Ich nehme, I take, etc.	Ich nehme
Du nimmeſt (nimmſt)	Du nehmeſt
Er nimmt	Er nehme
Wir nehmen	Wir nehmen
Ihr nehmet (nehmt)	Ihr nehmet
Sie nehmen	Sie nehmen
Imperfect.	
Ich nahm, I took, etc.	Ich nähme
Du nahmſt	Du nähmeſt
Er nahm	Er nähme
Wir nahmen	Wir nähmen
Ihr nahmet	Ihr nähmet
Sie nahmen	Sie nähmen
Present.	
Ich werfe, I throw, etc.	Ich werfe
Du wirfſt	Du werfeſt
Er wirft	Er werfe
Wir werfen	Wir werfen
Ihr werfet	Ihr werfet
Sie werfen	Sie werfen
Imperfect.	
Ich warf, I threw, etc.	Ich wärfe
Du warfſt	Du wärfeſt
Er warf	Er wärfe
Wir warfen	Wir wärfen
Ihr warfet	Ihr wärfet
Sie warfen	Sie wärfen

VIII.

Changes from Youth to Old Age.

The Causes of Varying Expression at Different Ages.

It is a commonplace to apply the terms "chubby" and "round" to the features of young children. The truth is that the bones have yet much to grow in size, the muscles of expression are not yet fully formed. Set and characteristic habits of expression have still to be acquired; there is a general mobility and plasticity of feature, with great variety of signs of pleasure and displeasure.

Rounded features of young children.

In youth there is a growth of skin out of proportion to the size of the bones, and an accumulation of fat which gives roundness and softness. Later in life the skin is more stretched by the growth of the bones, and becomes set according to habitual expressions, and limited to certain groups, according to mental and moral development. The fat, too, is often absorbed in thin people, while in others it becomes more abundant. In this case, however, the skin does not grow correspondingly, and the fat renders the surface tense, whence its texture and feel differ very much from that of children.

Skin stretched in later life.

Another contrast between youth and adult life is often seen in the red colour of the face. This is a peculiarity altogether distinct from the general colour or complexion, due to the presence of pigment. The red colour is produced by the greater distension of the capillaries, or minute blood-vessels of the skin, in red parts than in those which remain pale. The increased quantity of red blood passing through these vessels, seen through the partially translucent cuticle, gives a more or less deep colour, according to the amount of distension of the capillaries.

Colour of face.

In children brought up under healthy conditions, with a proper amount of exposure to sunlight and wind, those great health-agents, there is a natural redness of the cheeks, which becomes more marked as a temporary phenomenon during rational play or especially in the wind. The same flow of blood through the capillaries of the cheeks, accompanied by softness of skin, is an important constituent element in the beauty of women. This is heightened when there is a power of controlling the colour more or less, or by the involuntary variation of the flow of blood, both as to quantity and speed, seen in blushing.

Red cheeks of children.

Hard manual labour brings about a general increase in the amount of blood and in the fulness of the circulatory system. The capillaries of the skin share in this, and become perma-

Causes of red, brawny skin in adults.

nently red all over the body sometimes, but especially in parts much exposed. The face acquires a brawny, full-red appearance. Combined with this influence, due to muscular effort, there is frequently another, which in some cases affects the face most particularly. It is when some fluid or solid is constantly taken into the system, having an action on that portion of the nervous system which controls the size of the small vessels.

This change is very marked in many who indulge freely in alcoholic liquors. The capillaries of the cheeks and nose are not merely dilated, but they are gorged by the pressure of a full current of blood. The nervous system has lost control over the small arteries, and allows them to dilate to their full capacity. Consequently the capillaries they supply are constantly filled almost to bursting. In some cases the cheeks are marked with streaks of red, and the colouring matter of the blood may really exude from the vessels into the tissues around. Almost the same effects may be produced by prolonged exposure to bad weather alone.

Alcoholic excess.

In old age the skin is often very pale, owing to the withdrawal of blood from its vessels. The force of the heart's action diminishes with advancing life, and the blood is less in quantity. Naturally the skin is one of the parts most liable to suffer from these causes; and thus a *cold* skin is also produced, since there is a smaller quantity of warm blood to be driven with less force.

FIG. 17.—THE BASE OF THE BRAIN.

1, The olfactory nerve; 2, the optic nerve; 3, the third pair of nerves; 4, the fourth pair of nerves; 5, the trigeminus; 6, the sixth pair; 7, the seventh pair; 8, the eighth pair; 9, the ninth pair; *a*, superior convolution of the cerebrum; *c*, middle convolution; *b*, the occipital lobe; *d*, the pons Varolii; *e*, the medulla oblongata; *f*, the crura cerebri; *g*, the anterior part of the square lobe of the cerebellum; *h*, the anterior perforated spot; *i*, the infundibulum; *u*, the tuber cinerium; *z*, the corpora albicantia; *t*, the commissure; *l*, the under surface of the cerebellum; *x*, the longitudinal fissure; *m*, the flocculus or sub-peduncular lobule of the cerebellum; *n*, the notch between the hemispheres; *y*, convolutions of the cerebrum.

Together with the flaccidity and want of firmness, and the deficient flow of blood to the skin in old age, we find other changes, due to loss of elasticity, preventing the parts, when moved, from returning completely to their normal position. Consequently markings of various kinds make a permanent appearance upon the face, usually in the shape of transverse lines on the forehead, and of curves on the cheeks. These indentations are partly purely mechanical, for the tissues beneath are wasted, and the skin is too extensive for the surface it covers, and necessarily becomes puckered.

Lines and curves on the face.

Wrinkles, however, are, usually at least, connected with habitual expressions, and are very liable to be met with in those who have been the subject of exciting passions, the expression of which has not been restrained. Thus we sometimes see aged faces one mass of wrinkles, while in others, not unfrequently those whose passions have been calmed, and who have had much happiness through religious experiences, the face never appears to be so seamed. Anxiety and care, with an habitual straining of the facial muscles, are most potent in their effects on the face, and may cause wrinkles to appear in comparatively early life.

Wrinkles.

There is observable in the human frame a very decided correspondence between the development of the bones of the skull and the muscular and dermal structures covering them; witness the thick, heavy cheeks covering massive square jaw-bones. A similar construction, when combined with canine or "eye" teeth protruding forwards, and longer than usual, gives a noteworthy ferocity of aspect. How often do we see young persons, and especially women, who have well-developed and shapely incisor teeth, possessing in addition lips which are full and rich-looking and attractive!

Correspondence between inner and outer features.

We have previously mentioned the changes in the bones of the head in youth, the development of the frontal and maxillary sinuses, the increased prominence of the cheek-bones, and need now only allude to them as important factors in producing the manly expression of countenance. There is usually a smaller proportionate increase of these features in women.

The manly expression.

The replacement of the small teeth of the child by the large and massive ones of the adult gives a greater depth as well as length to the jaw-bones.

Changes in jaws.

At the same time, by the increase in number and size of the teeth, the angle of the lower jaw is carried backwards, and its outline comes more distinctly into view.

A characteristic part of the senile expression is again due to the loss of teeth and the wasting of the bony sockets which contained them. We have then a lower jaw of undiminished depth behind and as long from before backwards. The bones are necessarily brought into closer contact with one another in front, and the lower is raised by the space formerly occupied by the two rows of incisor teeth. The chin and the angle of the lower jaw are carried forwards, the nose and chin come much closer together, the lips are contracted and become less flexible. By these changes of course the cavity of the mouth is contracted and is too small to contain the tongue. Its free action is necessarily impeded, and both for this reason and the contraction and impaired mobility of the lips, articulation becomes defective.

Wasting of jaws in old age.

Changes in lips and mouth.

L.

The Infinitive Mood.

The infinitive mood is practically an indeclinable verbal substantive, capable of being used as a nominative or an accusative only; but for all other cases the gerund (*di, do, dum*) takes the place of the infinitive.

(1) *The Infinitive as a* SUBJECT *in a* SENTENCE.

The infinitive mood of a verb is used as a subject chiefly in connection with such quasi-impersonal verbs as *juvat*, it is a pleasure to; *delectat*, it delights; or such phrases as *certum est*, it is settled, *pulchrum est*, it is fine, etc.—as in *Juvat integros accedere fontes atque haurire*, to go to untouched fountains and to drink is a rapture.

(2) *The Infinitive as object in a sentence.*

The infinitive mood is used as the direct object by the poets—as in Horace, *Quid sit futurum cras fuge quærere*, as to what may happen on the morrow avoid inquiring.

[Note that sometimes the infinitive mood is used by the poets where a prose writer would use the gerund or the gerundive—as in Horace, *Non lenis precibus fata recludere Mercurius*, Mercury not to be moved by prayers to open the door of fate, where *lenis fata recludere* = *lenis ad fata recludenda*.]

(3) *The Infinitive with the Accusative Case.*

Verbs of *saying, thinking, knowing*, and *hearing* are followed by the accusative and infinitive in the preposition which they introduce—as in *Sentit animus se moveri*, the soul is conscious that it moves. Verbs also of expression of *feelings*—such as *joy, grief, wonder*—may be followed by the accusative and infinitive—as in *Miror te ad me nihil scribere*, I am surprised that you write nothing to me.

Various phrases, especially *impersonal* phrases, are followed by the accusative and infinitive—such as *manifestum est*, it is clear; *æquum est*, it is fair; *opus, necesse est*, it is necessary; *sequitur*, it follows; *constat*, it is a settled fact; *expedit*, it is expedient—as in *Constat ad salutem civium inventas esse leges*, it is a settled fact that laws were invented for the safety of the citizens. (But observe that *restat, reliquum est*, it remains, *proximum*, the next thing is, as well as *sequitur, expedit* are followed sometimes by *ut* with the subjunctive—as in *Si hæc enuntiatio vera non est, sequitur ut falsa sit*, if this proposition is not true, it follows that it is false.) Verbs signifying *willingness* or *permission* and the like, as well as their contraries, govern the accusative and infinitive—as in *Verres hominem corripi jussit*, Verres ordered the man to be arrested.

(4) *Verbs which govern the Infinitive Mood without the Accusative Case.*

Verbs which indicate *willingness, determination, ability, duty, lawfulness*, or the like, with their contraries, govern the infinitive mood—as in *Cæsar bellum cum Germanis gerere constituit*, Cæsar determined to wage war with the Germans. Verbs signifying *to begin, continue*, or *leave off*, also *to be or become accustomed*, govern the *infinitive mood*—as in *Illud jam mirari desino*, I am now ceasing to wonder at that thing.

Verbs signifying *to seem, to be thought, said, believed* (*videor, putor, credor, dicor*, etc.), are very seldom used impersonally, as in English. Thus we find *luna* (not *lunam*) *solis lumine collustrari putatur*, it is supposed that the moon is illumined by the light of the sun.

(5) *The Historical Infinitive.*

The Latin historians often use the imperfect infinitive instead of the corresponding tenses of the indicative mood—as in *Suo quisque metu pericula metui*, each one was measuring the magnitude of the dangers by his own fears.

(Observe that the usage of the infinitive mood is most commonly found in passages of description.)

Note that instead of the *future infinitive*, whether in the active or passive voice, we may use *fore ut* with the subjunctive mood—as in *Spero fore ut contingat id nobis*, I hope that such good luck will fall to our lot.

Self-Examination Questions and Exercises.

Describe the usage of the infinitive mood as the subject and as the object of a sentence, with examples. What verbs usually take after them the accusative and infinitive mood? Give examples. What impersonal phrases take after them the accusative and infinitive, and what take after them the subjunctive mood with *ut*? Give an example of each of these usages. What is the usual construction with verbs expressive of joy, wonder, or other feelings? Give examples. What is the construction usually followed in the case of verbs of *willingness, permission*, and their *opposites*? Mention verbs and the kind of verbs which govern the infinitive mood without the accusa-

tive case, and give examples. What do you mean by the historical infinitive? and what tense is generally so used, and with what special object? In what kind of passages do you find chiefly this usage? What paraphrase may be used in active and passive voices for the future infinitive? Give an example of the construction.

Translate into English :—

Clamabant homines, fore ut ipsi se Dii immortales ulciscerentur. Interea Manlius in Etruria plebem solicitare. Discere est omnibus utile. Nonne invideri est stultissimum? Mori nemo sapiens miserum dixerit. Captâ urbe, passim cædes, passim incendia, turpissima omnia fieri (passim = *everywhere*). Multi sequi, fugere, occidi, capi. Judices urbis hujus maximæ pecuniâ magnâ corrupisse dicitur. Ille miserrimus patriæ legibus parere subibat. Nonne multa utilissime discere et docere nolebat? Videor mihi lecturus esse hunc doctissimum librum. Hos libros legere jamdudum cæpi. Aio futurum ut libri legantur. Aiebam fore ut carmina Latina et Græca optima legerentur ab omnibus. Mene desistere victam! Ubi voles pater esse, ibi esto. Incipe, parve puer, matrem cognoscere tuam. Cupio in tot et tantis periculis urbis me non negligentem videri. Malum mihi videtur esse mors. Proximum est ut doceam Deorum providentiâ mundum hanc nostrum administrari. Majores nostri corpora juvenum firmari labore voluerunt. Cupio me esse clementem. Amicitia, nisi inter bonos homines, esse non potest. Certum est liberos a parentibus amari. Legem brevem esse oportet, quò facilius ab imperitis teneatur. Thales Milesius dixit aquam esse initium omnium rerum. Pro urbes multa precatus est. Nec quisquam vitabit celerem sequi Ajacem. Salvum te jam advenire admodum gaudemus.

Translate into Latin :—

It is useful to read good books; but it is more useful to read the best books, is it not? (begin the sentence with *nonne*). I say (use *aio*) that I shall read every day the best books. It is expedient to our country to do these things well. To die for one's own country is a sweet and glorious thing. They are said to be about to return home. To lie is disgraceful. All men were willing to see the beautiful and great city of Rome, the capital (*caput*) of the whole world. They were not able to return quickly. Pyrrhus, though an enemy, did not cease to admire and to praise the courage of the Roman forces (*copiæ*). Writing or to write is not a very easy thing. Was he unwilling to obey the laws of his country and the commandments of his parents? It is supposed that I should have read all the Latin authors on the art of poetry (for "on" use *de*). I remembered that I had not done that thing which you wish should be done. It follows that no man should be called blessed until after his death. He was rightly called the father of his country and the glory of the human race (for "glory" use *decus*). Can a good and wise man ever (*unquam*) wish to utter a lie? Socrates is said to have been by far (*multo*) the wisest of all men. The first legion having been routed (*fugatâ*—use ablative absolute), the enemy began to fly away from the field of battle. Who is reported to be the father of the Roman state? (use *respublica*). To envy is not the duty of the wise men (use the genitive case for the duty).

V.

Grinding Machinery.

Grinding operations may be roughly divided into two classes—namely, those in which the substance ground is required in the form of a powder, and those that have for their object the shaping of the substance by grinding off certain parts of its surface. It will be convenient to first consider the machines suitable for the latter purpose, on account of their greater simplicity.

The most primitive grinding machines possible, if, indeed, they may be dignified with such a name, are exemplified by the common oil-stone and the razor-strop. We have here flat surfaces of the necessary hardness on which the tool is rubbed backwards and forwards by hand. In some cases it is more convenient to move the stone than the tool, as in the sharpening of scythes; in others again it is preferred to move both the tool and the grinder, as when a butcher sharpens his knife upon a steel. In these cases it should be observed that a change in the motion does away with the necessity for a flat grinding surface. Such operations as these are always slow, uneven, and often imperfect, yet in a vast number of cases it is impossible to improve upon them with advantage, on account of the cheapness and portability of the apparatus. But when the amount of grinding required is considerable, as in re-making a broken tool, or when grinding becomes the principal instead of the occasional employment of the workman, then the portability of the apparatus used becomes a matter of minor importance, and mechanical contrivances may be employed with advantage.

The ordinary grindstone of the workshop is a thick solid wheel of stone supported on an axle and turned by a crank fitted with either a handle or a treadle. The substance to be ground is pressed against the flat edge of the stone, which is kept wet by a small stream of water, or by immersing the lower part of it in a trough of water. The stones of the peripatetic knife-grinder are much smaller and consequently lighter, and therefore require the addition of a fly-wheel, that the intermittent action of the treadle may be rendered continuous.

An almost endless variety of operations are performed by means of small revolving wheels, either of stone, iron, wood, or other suitable material, the motion being obtained by means of steam power. Fig. 17 shows how "cut glass" articles are finished; the flat surfaces that

constitute the pattern are ground and polished and so made more flat and true than if merely moulded. Glass "engraving" is a similar operation to "cutting," but the fineness of the lines necessitates the use of very small wheels with sharp edges varying from an eighth of an inch to two inches in diameter. These wheels are generally made of copper, and when in use have the required grinding power conferred upon them by the application of a little emery and oil to their edges. The hollow sides of the best razors and bayonets are produced by grinding them on very small stones; the work is tedious, and therefore expensive; but for operating on large surfaces that are required flat, as in axes, saws, etc., large stones are employed, weighing sometimes from two to three tons. Grindstones are usually made of sandstone, and may indeed be regarded as solid blocks of sand so far as their cutting power is concerned. Of late years emery powder has been moulded with various cements into the form of small grindstones, which are very successfully applied for grinding saws and other steel articles. As emery is only rivalled in hardness by the diamond itself, this contrivance much increases the resources of the grinder. The work of the lapidary is very similar to that of the glass cutter, but the great hardness of the gems he is called upon to cut makes it necessary for him sometimes to apply diamond dust to his wheels, while on the other hand he also uses wheels covered with leather, that he may be able to put a satisfactory polish upon some of the softer stones.

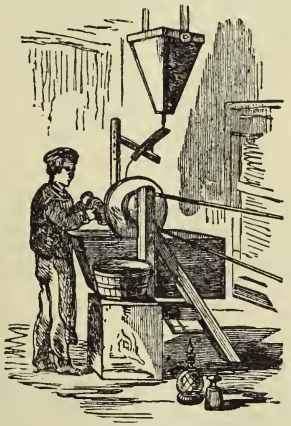


FIG. 17.

For grinding down large surfaces of metal to a perfectly flat surface, as in making the seat of a slide-valve, the motions of the work and of the grindstone are carefully regulated by means of machinery. The grinding machine, of which an end elevation is given in fig. 19, illustrates the means by which this object may be attained. This is a double-faced machine, the two sides being similar in arrangements. The grindstones *f* are fixed round the outer part of the face of two large wheels; the one on the left of the cut is shown in perspective, and marked *m*, while the one on the right-hand side is given in section to convey an idea of the relative size of the stones. The work is fixed to one of the face-plates, *e*, and is by it pressed against the grindstones at the same time that it is drawn horizontally along the bed that supports the face-plate. The main shaft, with its pair of compound grindstones attached, is revolved by passing a band that communicates with the motor employed round one of the driving-riggers, marked *g*. The double motion described above—namely, the circular motion of the stones combined with the straight horizontal motion of the work—brings every part of the surface being ground in its turn into contact with every part of the grinding surface of the stones, and so secures an evenly distributed grinding, and in the end a perfectly flat surface.

The simplest in action of grinding machines used for reducing substances to a state of powder, the finely divided stuff being required, is the common pestle and mortar. The mortar should be so shaped that the material being ground shall fall down to the bottom as soon as it has been worked up the side, and so return of itself to be reground. The action of the pestle is either to strike or to rub; and one great advantage of this simple apparatus is that these motions can be alternated, combined, or performed successively according to the requirements of the case. A skilful operator will thus obtain a better result than a novice in sometimes one-tenth the time. It should be observed that striking is generally more effective in breaking down the material to small pieces, while the rubbing reduces these to a powder of the necessary fineness.

Stamping-mills, such as are sometimes used at gunpowder works, may be regarded as mortars and pestles, the pestle or *stamp*, weighing perhaps one hundredweight, being worked up and down by machinery at the rate of from forty to sixty beats a minute. The materials to be pulverized are placed in mortar-shaped cavities cut in solid blocks of oak. The pulverization of the materials for making gunpowder is often effected by introducing them into a revolving wooden drum, lined with leather, and provided with internal projections, a number of bronze balls of about a quarter of an inch in diameter being put in at the same time. The blows that the materials receive from the balls, as well as by falling against the sides of the drum, rapidly and effectively reduce them to a fine powder; and as the operation is conducted in a closed vessel, there can be no loss by the flying about of the dust. Another kind of machine for powdering substances is what is called a "disintegrator" or "comminutor." It is not strictly a grinding machine at all, inasmuch as it is in effect a hollow drum containing the substance to be powdered, within which revolve very rapidly a number of beaters. The action is precisely that by which a stone may be broken if flung in the air and struck by a stick.

The rubbing motion that is efficacious in producing a fine powder with the pestle and mortar is also seen in the mills used for the production of flour from grain. From the earliest times, two millstones in a horizontal position, the lower one fixed while the upper one is caused to revolve, have been used for the preparation of meal. The hardness of the

"nether mill-stone" is proverbial. In modern mills these stones are about 4½ feet in diameter, and the upper one is turned by machinery at the rate of 100 to 120 revolutions per minute. In the largest mills steam power is employed; but the number of windmills that are to be seen in almost every district are evidence that a considerable quantity of flour is ground without consuming any fuel for the purpose. It is impossible here to enter at all fully upon the construction of windmills; it must suffice to say that the sails are so arranged that the surface opposed to the wind can be regulated, generally by mechanism similar to that of a venetian blind, and that they are kept straight to the wind by means of the fan at the back of the mill. This fan revolves in opposite directions according to the side upon which the wind strikes it; but is perfectly stationary when its edge is presented to the wind, and is so connected with the cap of the mill that this is slowly turned upon its vertical axis by its revolutions. The revolutions of the nearly horizontal shaft that carries the sails are caused to turn the vertical shaft with which the stone is connected by means of a pair of cog-wheels arranged similarly to those shown in fig. 18. A different system, however, is now coming into use in the grinding of flour. The grain is passed through several series of rollers, by which it is gradually crushed into powders of various degrees of fineness. The separation of husk from flour is said to be better effected by this method, as well as a greater variety of qualities in the flour.

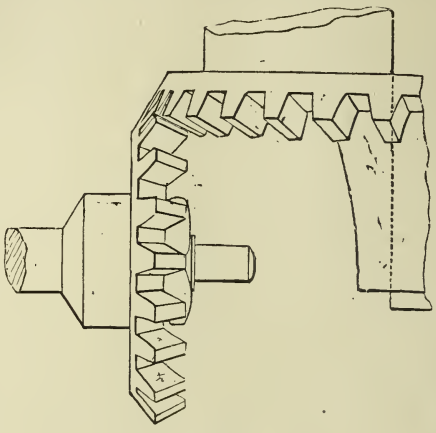


FIG. 18.

The grinding of many substances is effected more perfectly by a pressing instead of a rubbing action, and this is especially the case where the substance is wanted as a paste rather than a dry powder. The instruments by which this is carried out are called *crushing mills*, an example of which is illustrated in fig. 20. The horizontal wheel shown at the top of the figure is turned by the motor employed, and the revolutions of the vertical shaft attached to it cause the two vertical stones to roll round in the circular bed of the apparatus. The material being ground is turned over occasionally and brought under the edges of the stones by an attendant, or by self-acting scrapers attached to the mill. Mortar-mills are of this construction. An apparatus working according to the same principles is used for the preparation of chocolate paste, etc.; but for this purpose it is found more convenient to have the rollers of small diameter compared with their length, and to have at least four of them rolling round in the same bed.

There is one other general form of grinding machines—namely, those where the substance is rubbed against a roughened surface, as in the nutmeg-grater, or where the grinding is performed by means of a toothed metal cylinder revolving in a suitable case, as in the ordinary hand coffee-mill. There is a gradually decreasing space between the moving and the fixed part of the mill, so that the substance is gradually broken smaller and smaller until it finally passes through into the receptacle beneath. A machine working on this principle (but horizontally) for grinding grain is shown in fig. 21.

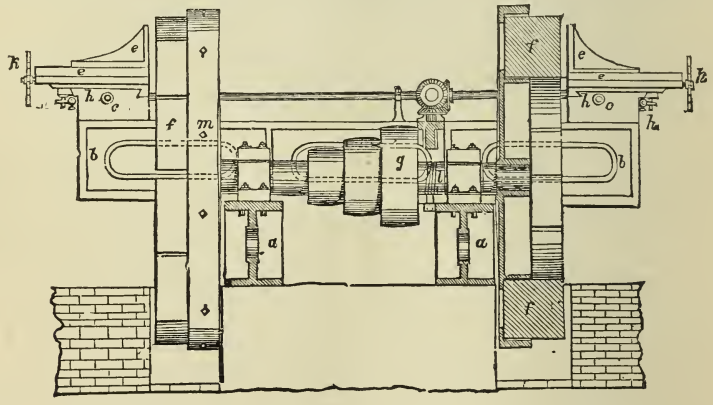


FIG. 19.

VIII.

Chaucer, Gower, Barbour, and Blind Harry.

To resume speaking of the *Canterbury Tales*:—Among the other travellers are a Merchant, well clothed and well mounted, and much given to talk of his wealth; a Franklin or country gentleman, the most hospitable of men, who kept open table in his hall, in whose house "it snewen (snowed) of meate and drinke," and who had been chosen as knight of the shire; a Wife of Bath, a most strong-minded woman, who had been on many a pilgrimage before, thrice in Jerusalem, at Rome, at St. James's shrine in Galicia, at Boulogne, and at Cologne (this worthy pilgrim, who in her time had married five husbands, rode in masculine fashion, with "on hire fete a pair of sporres sharpe");—a Sergeant-of-law, discreet and of great reverence; a Cook who could wash and seethe and boil and fry; a Shipman from Dartmouth, the master of the good bark *Magdelaine*; a Miller, a somewhat swaggering fellow, very strong and sturdy, much given to filching corn and levying his toll thrice, and playing on the bagpipe; an Oxford Scholar, or Clerke of Oxenford, poor, but learned and companionable, riding on the leanest horse in the company. These and various others made up the motley group. The host, a man worthy of the distinguished meeting, entertained his guests well,—

The Merchant the Franklin, etc.

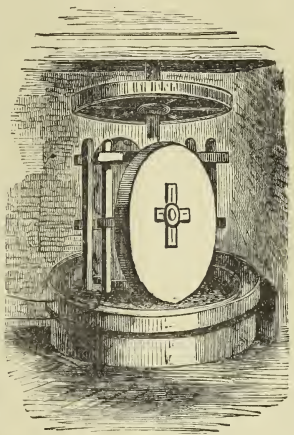


FIG. 20.

"And servid us with vitaile of the beste.
Strong was the win, and wele to drinke us leste.
A semely man our hoste was withalle,
To bene a marshall in a lordis hal.
A large man was he, with eyin stepe,
A fayrer burgeis is ther none in Chepe.
Bold of his speche, and wise, and wel ytaught,
And of manhode lakid him righte nought.
Like thereto was he a right mery man."

After supper the jovial host brings out a proposal to the effect that the guests shall travel in company to Canterbury and home; and that each of them "in this viage shall tellen tales tway, and homeward he shall tellen other two," and that the traveller who shall be considered to have told the best stories shall be entertained at supper at the expense of the rest. The proposition finds great favour with the company, and it is decided that the host shall be the judge as to the merits of the various tales. When they set out next morning, accordingly, the jolly host calls upon them all to draw lots to decide who shall tell the first tale:—

The host's proposal.

"He which that hath the shortest shal beginne.
Sire Knight (quod he), my maister and my lord,
Now draweth cutte, for that is min accord.
Cometh nere (quod he), my lady Prioresse,
And ye, sire Clerk, let be your shamefacednesse,
Ne studie nought; lay hand to, every man."

Very appropriately, the lot falls upon the knight, who accordingly tells the first story, the noble tale of Palamon and Arcite. The squire tells "the story of Cambuscan bold," as Milton phrases it,—the story of the King of Tartary and the knight who rode the wondrous horse of brass, and bore the marvellous mirror, sword, and ring, each endowed with magic virtues. The clerke of Oxenford tells the tale of Patient Grisilde, taken from Boccaccio, and since, in various forms, lyric and dramatic, adopted by the whole of Europe. The nun's priest tells the tale of the Cock and the Fox; the merchant gives the company the tale of January and May, which have been respectively modernised by Dryden and Pope; and the miller contributes a coarsely humorous tale of two "clerkes." The yeoman and the plowman do not tell stories; and the five Londoners, the haberdasher, carpenter, webbe, deyer, and tapiser, are likewise silent characters. Mine host is most judiciously employed as a kind of chorus. The work, unfortunately, was not completed by Chaucer. It would have been good to know mine host's judgment on the various tales, and to have been present at the adjudging of the prize; but, as it stands, the poem is a noble monument of the English life of the fourteenth century. We learn the events in the chronicles; but the manners, customs, speech, and humours of the period, as displayed by a gathering of the various classes of Englishmen, we find photographed, so to speak, in the great room of the

The various stories.

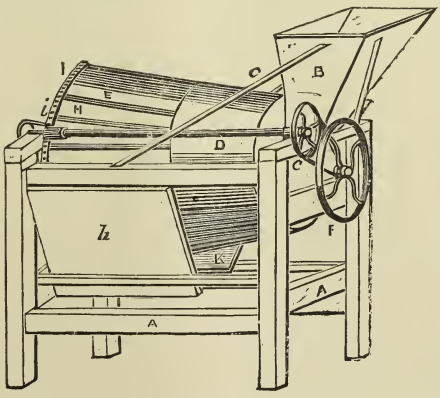


FIG. 21.

Southwark inn by the genius of the Father of English Poetry.

Contemporary with Chaucer, and in various ways associated with him, as a friend and fellow-writer, but far inferior to the author of the *Canterbury Tales* in genius, is the worthy JOHN GOWER, whose ashes lie entombed in the church of St. Mary Overies, now St. Saviour's, Southwark. Gower was, by a few years, the senior of Chaucer, being born, it is conjectured, in 1325; he also survived the greater poet, dying, an old blind man, in 1403. He belonged to a family of high position, now represented by the Dukes of Sutherland, and was the proprietor of two manorial estates in Suffolk and Nottinghamshire. "If Chaucer had not existed," says Warton, in his *History of English Poetry*, "the compositions of John Gower, the next poet in succession, would alone have been sufficient to rescue the reigns of Edward III. and Richard II. from the imputation of barbarism." "The moral Gower," as Chaucer calls him, is generally grave, sententious, and didactic, aiming to teach rather than to amuse.

John Gower.

Gower produced three works, or rather a great work in three divisions. The first is *Speculum Meditantis* (the Mirror of Meditation), a didactic poem in ten books, written in French rhymes, and therefore not belonging to English literature. The second work is *Vox Clamantis* (the voice of one crying in the wilderness), This is a Latin poem in seven books, the chief subject being the insurrection of the commons in Richard II.'s time. The poem written in English is the *Confessio Amantis* (the Lover's Confession), said to have been undertaken by Gower at the command of King Richard, who honoured the poet by inviting him into the royal barge on the Thames and desiring him to write something new. On the tomb of Gower the three volumes are represented.

Gower's three works.

The *Confessio Amantis*, a dialogue between a lover and his confessor, is full of allegorical characters, — Idleness, Avarice, Thieving, etc. A critic aptly says, "What Gower wanted in invention he supplied from his common-place book, which appears to have been stored with an inexhaustible fund of instructive maxims, pleasant narrations, and philosophical definitions. It seems to have been his object to crowd all his erudition into this elaborate performance." Gower had read the metrical romances, and likewise some classical authors, especially Ovid; and he often makes use of his reading in a somewhat confused fashion. Of Chaucer's genius for painting character and scenery he was entirely destitute. The *Pantheon*, or *Memoriæ Seculorum*, a Latin work two centuries old, by Godfrey of Viterbo, furnished Gower with many incidents recorded in the *Confessio Amantis*. Colonna's *Romance of Troy*, the *Gesta Romanorum*, and the *Romance of Sir Launcelot*, were also used by Gower. Among the classic authors, he cites Ovid, Horace, Cicero, and Virgil.

The "Confessio Amantis."

Gower may be seen at his best in the following specimen from the *Confessio Amantis*. It describes how Rosiphele, a beautiful princess, sees a vision of a cavalcade of beautiful ladies pass before her:—

"Whan come was the moneth of Maie,
She wolde walk upon a daie,
And that was er the son arist (arose),
Of women but a feu it wist,
And forth she went prively,
Unto a parke was juste by,
All softe walkende on the gras,
Tyll she came there, the launde was
Through which ran a great rivere,
It thought her fayre; and said, here
I will abide under the shawe:
And bad hir women to withdrawe:
And ther she stood alone stille
To thinke what was in her wille.
She sighe (saw) the swete floures sprynge,
She herde glad fowles synge;
She sigh beastes in her kynde,
The buck, the doo, the hert, the hynde.
* * * *
And as she cast hir eie aboute,
She sigh (saw) clad in one suit, a route
Of ladies where thei comen ride
Alonge under the woodde side;
On fayre ambulende (ambling) hors thei set,
That were al whyte, fayre, and gret;
And everichone ride on side (sideways),
The sadels were of such a pride,
So riche sight she never none;
With perles and golde so wel begone,
In kirtels and in copes riche,
Thei were clothed all aliche (alike),
Departed even of white and blewe,
With all lustes (colours) that she knewe
Thei wer embroudred over all:
Her (their) bodies weren longe and small,
The beautee of hir fayre face,
There mai none erthly thing deface:
Corownes on their heades thei bare,
As eche of hem a quene were,
That all the golde of Cresus hall
The least coronall of all
Might not have boughte, after the worth,
Thus comen thei ridend forthe.
The kynges doughter, whiche this sigh,
For pure abasshe drewe her adrigh,
And helde hir close undir the bough."

To this first period of English literature likewise belong some rhymed chronicles of no mean merit by Scottish authors. Chief among these is the metrical chronicle called *The Bruce*: giving an account of the actions of King Robert I. in the struggle for Scottish independence. The poem is the work of JOHN BARBER or BARBOUR, Archdeacon of Aberdeen, a Scottish historian and poet. Barbour received a pension from the King of Scots, and, by the industry of the late Mr. Robertson, Keeper of the Records in Edinburgh, a receipt for the money thus paid was discovered some years ago. That Barbour studied in England appears from a safe-conduct granted by King Edward III. in 1357 to "John Barber, Archdeacon of Aberdeen, with three scholars in his company, coming in order to study in the University of Oxford, and perform his scholastic exercises." Though few will agree with an enthusiastic admirer of the learned Archdeacon, that his style is not inferior in beauty to that of his contemporary Chaucer, there is yet no doubt that Barbour's *Chronicle* is far in advance of the general compositions of his time. Sir Walter Scott, an indefatigable student of the literature of his country, evi-

Rhymed Chronicles by Scottish authors.

dently read Barbour's *Chronicle* with great interest, and even seems to have almost paraphrased some of its passages in his works.

Barbour, Wyntoun, Blind Harry.

ANDREW WYNTOUN, a priest of St. Serf's monastery in Lochleven, also wrote a rhymed chronicle, rich in historical anecdote; at a somewhat later date we have the chronicle of BLIND HARRY, or HARRY THE MINSTREL, who wrote and sang the adventures of Wallace, the hero of Scotland. The chronicle is in eleven books, in the rhymed ten-syllable line, and was rendered into modern English by William Hamilton of Gibertfield. It is lively and spirited, and shows real literary merit; and is said to have been a favourite book with Burns, who himself immortalized in his verse the "Scots wha hae wi' Wallace bled."

Specimen of Barbour's writing.

The following passage, describing the death of the brave knight, Sir Henry de Bohun, just before the battle of Bannockburn, will give the reader an idea of the style of Barbour's *Chronicle*. The spelling is modernised in this extract:—

"And when the king wist that they were
In hale battle, comand so near,
His battle gart he weel array.
He rade upon a little palfray,
Lanecht and joly arrayand
His battle, with an ax in hand.
And on his bassinet he bare
An hat of tyre aboon ay where;
And thereupon, into takin
Ane high crown, that he was king.
And when Gloster and Hereford were
With their battle approach and near
Before them all there came ridand,
With helm on heid and spear in hand,
Sir Henry the Boon, the worthy,
That was a wicht knicht, and a hardy,
And to the Earl of Hereford cousin;
Armed in arms gude and fine;
Came on a steed a bowshot near,
Before all other that there were;
And knew the king, for that he saw
Him sae range his men on raw,
And by the crown, that was set
Also upon his bassinet."

The knight, thinking that he should easily overcome the king "and have him at his will." "sin he him horsit saw sae ill," rides forth against Bruce; but

"Sir Henry missed the noble king;
And he, that in his stirrups stude,
With the ax, that was hard and gude,
With sae great main raucht him a dint,
That nouther hat nor helm micht stint
The heavy dush, that he him gave
That near the head till the harns clave.
The hand-ax shaft pushit in tway,
And he down to the yird gan gae,
All flattings, for him failit micht.
This was the first straik of the fight
That was performit douchtily."

Sir Walter Scott's version, in some respects, follows this chronicle very closely. In describing the onset of De Boune, he says:—

"The partridge may the falcon mock,
If yon slight palfrey bear the shock;
But, swerving from the knight's career,
Just as they met, Bruce shunned the spear.
Onward the baffled warrior bore
His course, but soon his course was o'er.
High in his stirrups stood the king,
And gave his battle-axe the swing
Right on De Boune, the whiles he passed
Till that stern dint, the first, the last,
Such strength into the blow was put,
The helmet crushed like hazel-nut,
The axe-shaft with its brazen hasp
Was shivered to the gauntlet grasp.
First of that fatal field, how soon,
How sudden fell the fierce De Boune."

The spelling of Barbour is less intelligible than that of Chaucer, as will be seen in the following lines on Freedom:—

"A! fredome is a nobill thing!
Fredome mayse man to haiff liking!
Fredome all solace to man giffis,
He levys at ese that frely levys!
A noble hart may haiff nane ese,
Na ellys nocht that may him plese
Gyff fredome failythe: for fre liking
Is yearnyt our all other thing.
No he that ay hase levyt fre,
May nocht knaw weill the propyrte,
The angyr, na the wrechyt dome,
That is cowplyt to foule thyrldome."

In the modern spelling:—

"Ah! freedom is a noble thing,
Freedom makes man to have liking,
Freedom all solace to man gives,
He lives at ease that freely lives.
A noble heart may have no ease,
Nor else naught that may him please,
If freedom faileth; for free liking
Is yearned (for) above all other thing,
Nor he that aye has lived free,
May not know well the property,
The anger nor the wretched doom
That is coupled to proud thraldom."

Blind Harry's style.

A peculiarity in the verse of Blind Harry's *Chronicle* is the rest or cæsura on the fourth syllable, which gives a certain swing to the line by dividing it into two unequal portions. Wallace has slain some English soldiers who have tried to take from him by force the fish he had caught in Irvine water. He goes home to his uncle, Sir Ranald Wallace (who is called his *eme*, from the German *Oheim*, or *Ohm*), and the latter prudently counsels him to leave the neighbourhood. Wallace goes accordingly, after taking leave of his uncle. We are told how the young hero of Scotland

"Went till his *eme*, and told him of this deed,
And he, for woe well near worthit to weid (nearly went wild),
And said he: 'Son, thir tidings sits me sore,
And be it known, thou may tak scaith therefore.
'Uncle,' he said, 'I will no longer bide,
Thir southland horse let see gif I can ride.'
Then, but a child, him service for to mak,
His *eme's* sons he wuld not with him tak.
This gude knight said: 'Dear cousin, pray I thee,
When thou wants gude, come fetch eneuch frae me.'
Silver and gold, he gart on him give,
Wallace inclines, and gudely took his leave."

XXIV.

VOLTAIC ELECTRICITY (*continued*).

Electric fa..

IT is usual to represent the distribution of tension throughout a circuit in a graphic form by means of lines. A horizontal line called an *abscissa* is used to represent the circuit; vertical lines drawn perpendicular to certain points in the abscissa,

and called *ordinates*, represent the tension at corresponding points in the circuit. If a line is drawn joining the upper ends of all the ordinates, that line will indicate the distribution of the tension in the circuit. The inclination or steepness of this line represents what Ohm termed the *electric fall*. The electric fall is, however, more correctly defined as the decrease in the length of the ordinate for the unit of length of the abscissa.

All this may at first sight seem rather puzzling to an amateur, but perhaps the difficulty may be done away with if we give a rough diagram such as that in fig. 83. It will, of course, be understood that in this and all similar diagrams the lines must be *drawn to scale*—that is to say, a given length of the horizontal line must represent a given (but not necessarily equal) length of the circuit, and a given length of the vertical line must represent a certain amount of tension.

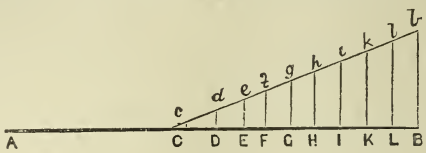


FIG. 83.

Let AB, then, be the *abscissa* representing the length of a certain circuit. And let C*c*, D*d*, E*e*, etc., be vertical lines (*ordinates*), representing the tensions at certain points in the circuit AB. The line C*b* indicates the distribution of tension in the circuit, and it was to its inclination that Ohm applied the term *electric fall*. In strictness, however, the electric fall is proportional to the difference in length between any two neighbouring ordinates. Finally, the area of the triangle C*b*B represents the total charge of the wire.

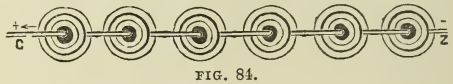


FIG. 84.

Ohm, in his researches, assumed that the passage of electricity from one section of the wire to the other was due to the difference in tension of the two portions.

Summary of Ohm's laws.

The laws which Ohm deduced from his experiments may be summarised as follows, and readily remembered by the student:—

1. *The intensity of the current is equal to the electromotive force divided by the resistance.*

2. *The intensity of the current is inversely proportional to the length of the conductor, and directly proportional to its cross-sectional area as well as to its conductivity.*

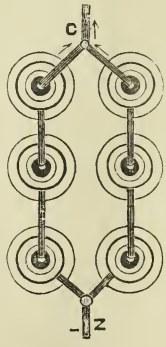


FIG. 85.

The first of these laws needs no comment; the second requires perhaps a little explanation.

Comments upon Ohm's laws.

In the first place it means that, other things being equal, the *shorter* and *thicker* the wire the less the resistance, and therefore the greater the intensity of the current. The conductivity of a wire or other conductor is of course different in each case, and must be specially determined; but being known, the greater this conductivity the greater the intensity of the current. The facts embodied in the second law may be formulated in a somewhat different manner, thus:—

(1) If the wire uniting the poles of the battery is of the same material, and of the same thickness throughout, the "electric fall" will be the same throughout the wire.

(2) If the wire is of the same material, but not of a uniform thickness, the "fall" is steeper on the thin wire than on the thick; it is, in fact, inversely proportional to the cross-sectional area of the wire.

(3) If two conducting wires are employed, of the same thickness but of different resistances, the electric fall is steepest on the more resisting wire. The "fall" is directly proportional to the specific resistances of the wires.

These laws of Ohm, which have been since verified by Kohlrausch, are very useful in enabling us to determine how best to adapt a battery to the special work it has to perform.

Application of Ohm's laws.

The first law may be stated as a formula, thus:—

$$I = \frac{E}{R},$$

I representing the intensity, E the electromotive force, and R the resistance.

Now, in applying this to the battery, we must remember that R is in this case made up of two elements,—the resistance in the fluid between the plates, and the resistance outside the battery in the wire, etc. The former is called *internal* resistance, and is usually represented by R; the latter is termed *external* resistance, and is represented by *r*. Our formula therefore may be written: $I = \frac{E}{R + r}$.

Now, in a case where a short thick copper wire is employed to connect the poles of the battery, *r* is so small in comparison with R that it may be neglected; and inasmuch as R will be correspondingly increased the greater the number of cells, we should get little or no more effect from a large battery than from a single cell. If, however, the external resistance is very great, as in the case of working the electric light or the electric telegraph, then R is so insignificant in comparison with *r* that we may neglect it. Now *r* remains constant, and therefore the more cells we employ the better; and within certain limits the intensity is proportional to the number of elements employed in the battery.

If the plates of a battery are enlarged, there is no increase in the electro-motive force; but the cross-section of the conducting medium being increased, the resistance will be correspondingly less, and therefore the intensity greater. Increasing the size of the plates will not, however, indefinitely increase the intensity.

By those laws of Ohm which we have just investigated, we may easily determine, when the resistances of a battery are known, the most efficient way in which the cells of the battery may be coupled together.

To determine the best arrangement for a battery.

If, for instance, we have a battery of six cells, we may couple the cells up in four different ways. First we may unite the cells in the ordinary "tandem" fashion, by joining the copper of one to the zinc of the next, as shown in fig. 84. Again we may unite them, as in fig. 85, in three pairs, the two coppers and the two zincs of each pair being joined together. A third way would be to unite them in two threes, as in fig. 86. Lastly, all the coppers and all the zincs may be respectively joined together so as to form one large cell, as shown in fig. 87.

Now, if we suppose that the internal resistance R of each cell is say 4, and the external resistance $r = 12$, we can easily calculate which of these four methods of coupling the battery will be most advantageous.

Arithmetical calculations.

To take the first case, the following formula will represent the conditions which will obtain—

$$I = \frac{6E}{6R + r} = \frac{6E}{6 \times 4 + 12} = \frac{6E}{36}.$$

In the second case, by uniting the cells into pairs, we have virtually doubled the size of the plates, each pair of cells thus coupled being equal to a single cell with plates of double size. This doubling the size of the plates will, in accordance with the law that "the resistance is inversely proportional to the sectional area of the conductor," halve the resistance; and the electromotive force remaining in each of the three large cells being the same as in the small ones, our formula will become—

$$I = \frac{3E}{3\frac{R}{2} + r}$$

$$= \frac{3E}{3 \times \frac{4}{2} + 12} = \frac{3E}{18} = \frac{6E}{36}.$$

In this instance, therefore, no benefit would arise from doubling the size of the plates. Let us see how the third arrangement comes out when tested arithmetically. The formula will now be—

$$I = \frac{2E}{2\frac{R}{3} + r} = \frac{2E}{2 \times \frac{4}{3} + 12} = \frac{2E}{\frac{8}{3} + 12} = \frac{6E}{44}$$

This method, then, would be disadvantageous. In the last case the formula becomes—

$$I = \frac{E}{\frac{R}{6} + r} = \frac{E}{\frac{4}{6} + 12} = \frac{6E}{76}$$

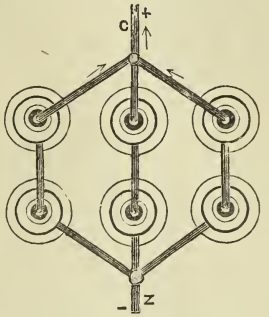


FIG. 86.

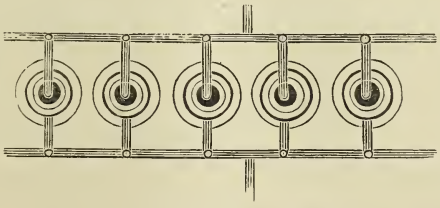


FIG. 87.

This would be a still worse arrangement with the supposed values of R and r. It must, however, be distinctly understood that the question as to which of these methods of coupling up a battery is the most economical depends entirely upon the *relative values* of R and r, and will differ in almost every case. If, for instance, the values of R and r were respectively 5 and 9, the foregoing formulæ would be as follows:—

$$(1)\quad I = \frac{6E}{6R + r} = \frac{6E}{6 \times 5 + 9} = \frac{6E}{39}$$

$$(2)\quad I = \frac{3E}{3\frac{R}{2} + r} = \frac{3E}{3 \times \frac{5}{2} + 9} = \frac{3E}{\frac{15}{2} + 9} = \frac{6E}{33}$$

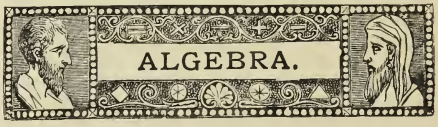
$$(3)\quad I = \frac{2E}{2 \times \frac{R}{3} + r}$$

$$= \frac{2E}{2 \times \frac{5}{3} + 9} = \frac{2E}{\frac{10}{3} + 9} = \frac{6E}{37}$$

$$(4)\quad I = \frac{E}{\frac{R}{6} + r} = \frac{E}{\frac{5}{6} + 9} = \frac{6E}{59}.$$

Here the most advantageous method of arranging the battery would be in three pairs, and the most disadvantageous would be that of uniting the cells so as to form a single element. In like manner, by taking different values for the internal and external resistances of any battery, the best method of coupling the elements may easily be ascertained.

If, however, we consider the equation $I = \frac{E}{R + r}$ in its application to an unlimited number of any certain cells and a given external circuit, and bear in mind that by increasing E (that is, adding more cells, as in fig. 84), we increase R proportionally, we shall find it most economical to make R and r equal to one another. So that we can easily tell how many cells to employ for any given circuit—*i.e.* to overcome any given resistance—if the resistance of the circuit and of one cell are known by dividing the resistance per cell into the resistance of what is to form the external circuit.



VII.

EQUATIONS.

AN algebraical *equation* is an assertion of the equality of two algebraical expressions. It is represented by writing the two expressions with the sign of equality (=) between them.

Thus the expression A = B is an equation, asserting that the quantity A is equal to the quantity B.

Any of the examples which the student has worked might be stated as equations; thus the first example of addition might be stated

$$5a - 3b + 4a - 7b = 9a - 10b.$$

The student will easily see that this equation, or statement of the equality of the two expressions $5a - 3b + 4a - 7b$ and $9a - 10b$, is always true, whatever may be the value of a and b. But suppose now that we have such a statement as this—

$$x + 3 = 8.$$

It is clear that this is not always true, but only when x is 5. This is a very important difference. In truth, the first equation is something more than a statement of mere equality—it is a statement of identity, and is therefore called an *identical* equation. The latter equation, with which we have now specially to deal, is called a *conditional* equation, because it is true only *on condition* that x has some particular value,—5 in the present case.

In a conditional equation we have two sets of quantities—those whose values we know, and those whose values we wish to find. Thus, in the above equation,

$$x + 3 = 8,$$

we wish to find what value the letter x must have in order that the statement of equality may be true. The letters whose values we wish to find are called the *unknown quantities*; and of these we may have only one, as in the above equation, or several. It is customary, as was before stated, to denote unknown quantities by the last letters of the alphabet, and known quantities by the first letters. The process of finding the particular value of the unknown quantity is called solving the equation; the particular value of the unknown quantity is called the *root* of the equation, and it is said to *satisfy* the equation.

An equation which contains only the first power of the unknown quantity is called a *simple* equation; and of the solution of simple equations we shall first treat. Before doing so, however, it is necessary to call the student's attention to four *axioms*, as they are called, on which are based all the rules for the solution of equations:—

I. If equal quantities be added to equal quantities, the sums will be equal.

II. If equal quantities be subtracted from equal quantities, the remainders will be equal.

III. If equal quantities be multiplied by equal quantities, the products will be equal.

IV. If equal quantities be divided by equal quantities, the quotients will be equal,

By the application of these axioms all equations are solved; but it is more convenient to apply in practice certain consequences of these axioms than to apply directly the axioms themselves. From Axioms I. and II. follows this rule:—

ANY TERM MAY BE REMOVED FROM ONE SIDE OF AN EQUATION TO THE OTHER SIDE, PROVIDED ITS SIGN BE CHANGED.

This is easily proved. Take our former example—

$$x + 3 = 8.$$

If, applying Ax. II., we subtract 3 from each side, we get

$$x + 3 - 3 = 8 - 3.$$

The $+3$ and -3 cancel, and we have left

$$x = 8 - 3.$$

Thus the 3 has been removed from the left side of the equation to the right, and its sign changed.

In the same way, if we have an equation consisting wholly of letters, as

$$x + a = b,$$

subtracting a from each side we have

$$x + a - a = b - a,$$

that is,

$$x = b - a.$$

If we had $x - a = b$, we should (Ax. I.) add a to both sides, and we should have

$$x - a + a = b + a$$

that is,

$$x = b + a.$$

If the sign of each term of an equation be changed, the statement of equality is still true. If $x = a$, then multiplying the equal quantities by -1, we have $-x = -a$. If $x - a = b - c$, then $a - x = c - b$.

Ax. III. enables us to clear an equation of fractions. To do this we have only to multiply each side of the equation by the common denominator of the fractions.

Thus, suppose we have to deal with such an equation as

$$x + \frac{x}{2} + \frac{x}{5} = 9,$$

we multiply each side of the equation by 10, the common denominator of the fractions, and we get

$$10x + 5x + 2x = 90.$$

Again, let

$$\frac{x}{3} - \frac{x}{5} = \frac{8}{6}.$$

Multiply both sides of the equation by the common denominator 30, and we get

$$10x - 6x = 40.$$

Again, let

$$\frac{x}{a} - \frac{x}{b} + \frac{x}{c} = \frac{2}{ac}.$$

Multiplying by abc, the common denominator, we get

$$bcx - acx + abx = 2b.$$

In all these illustrations of the axioms the student must observe that we get many new equations, or statements of equality, all of which are *true* if the original statement from which they are derived be true.

SOLUTION OF SIMPLE EQUATIONS.

Rule.—Clear the equation of fractions; transpose to the one side of the equation all the terms containing the unknown quantity, and to the other side all the terms not containing it; combine all the terms on each side as far as possible, and divide each side by the coefficient of the unknown quantity.

Note.—It is sometimes advisable not to clear at first wholly of fractions; but only practice can tell the student when to vary the work of solution.

Examples.

1. $2x + 10 = x + 15.$

Transposing, according to the above rule, we have

$$2x - x = 15 - 10$$
$$\therefore x = 5.$$

2. $\frac{x-2}{2} + \frac{x-1}{3} = \frac{7}{6}.$

Clear of fractions by multiplying both sides of the equation by the least common denominator 6.

$$3x - 6 + 2x - 2 = 7$$
$$5x - 8 = 7.$$

By transposition, $5x = 7 + 8 = 15.$
Dividing by 5, the coefficient of x,
$x = \frac{15}{5} = 3.$

3. $ax + b = cx + d.$

By transposition:

$$ax - cx = d - b,$$
or $(a - c)x = d - b.$

The coefficient of x is $a - c$, and dividing both sides of the equation by it we get:

$$x = \frac{d-b}{a-c}.$$

4. $\frac{a^2x}{bc} - \frac{d^2}{a} + bx = \frac{ex}{f} - b + (b + d)x.$

By transposition:

$$\left(\frac{a^2}{bc} + b - \frac{e}{f} - d - b\right)x = \frac{d^2}{a} - b;$$

that is, $\frac{a^2f - bce - bcd}{bcf}\,x = \frac{d^2 - ab}{a}.$

Clearing of fractions, etc.,

$$x = \frac{(d^2 - ab)bcf}{a^3f - abce - abcd}.$$

It sometimes happens that an equation contains a higher power than the first of the unknown quantity, and is yet a simple equation. Thus:

$$(x-2)(x-3) = (x-4)(x-5).$$

Simplifying by clearing away brackets:

$$x^2 - 5x + 6 = x^2 - 9x + 20.$$

This does not look like a simple equation, but we see that x^2 may be subtracted from each side, leaving

$$-5x + 6 = -9x + 20.$$

By transposition:

$$9x - 5x = 20 - 6$$
$$4x = 14$$
$$x = 3\tfrac{1}{2}.$$

The student will find it of advantage to exercise himself in substituting for x the value which he finds for it. Thus, to take our last example:

$$(x-2)(x-3) = (x-4)(x-5).$$

x, we have found, is $3\frac{1}{2}$, therefore

$(x-2)$ becomes $3\frac{1}{2} - 2 = 1\frac{1}{2}$
$(x-3)$,, $3\frac{1}{2} - 3 = \frac{1}{2}$
$(x-4)$,, $3\frac{1}{2} - 4 = -\frac{1}{2}$
$(x-5)$,, $3\frac{1}{2} - 5 = -1\frac{1}{2}$

The first side of the equation is:

$1\frac{1}{2} \times \frac{1}{2}$, *i.e.* $\frac{3}{4}$,

and the second side is

$-\frac{1}{2} \times -1\frac{1}{2}$, *i.e.* $\frac{3}{4}$ also.

Again:

$$5x^2 - 5x = 2x^2 + 4x.$$

We see in this case that we can divide each side of the equation by x. Doing so, we get

$$5x - 5 = 2x + 4.$$

By transposition:

$$5x - 2x = 5 + 4$$
$$3x = 9$$
$$\therefore x = 3.$$

L.

Germany and the Northern Powers. — Rise of Prussia.

Though the German empire nominally continued for a century and a half after the treaty of Westphalia, its real strength was shattered and destroyed in the terrible ruin brought by the Thirty Years' War. At the conclusion of that contest a new condition of things arose in Germany. The princes of the empire had contrived, at the treaty of Westphalia, to assert their position as independent rulers with regard to the emperor, and the power of the house of Hapsburg no longer weighed upon them as formerly. They aspired also to independent rule; to be despotic with regard to their subjects, and the estates of their various principalities. Passive obedience and non-resistance were government doctrines that found many advocates in the German empire; and the tendency of the period was towards arbitrary rule. The emperor, Ferdinand III., in his last diet, held in 1653, gave the princes the right to levy from their subjects taxes sufficient in amount to enable them to furnish the contribution they were bound to give to the common defence. Gradually this licence was enlarged and widened, until practically the various princes laid burdens upon their subjects at their own sole will and discretion; and the people were forced "obediently and unresistingly" to give what was demanded of them. Old charters and privileges, laws and compacts were disregarded; and no complaints of the oppressed community were heard or regarded in the imperial courts.

Decline of the German empire.

Increased power of the princes.

A time of grievous taxation and wrong now began for Germany. The produce of the farmer's and labourer's toil, and of the citizen's and trader's ingenuity, industry, and perseverance, was plundered and wasted for the maintenance of standing armies, expensive embassies, and luxurious and dissolute courts. Though in some districts trade, manufactures, and agricultural produce increased, the people remained poor, and had

The people oppressed and downtrodden.

nothing they could call their own. To the old feudal proprietary yoke, which demanded suit and service and tax on behalf of the landed proprietors, was now added the burden of taxation imposed by the government. There was no limit to the demands made upon the bulk of the people, who, unrepresented in the government, were completely at the mercy of the governing class. The more powerful among the governments obtained the so-called *privilegium de non appellando*, by which they became irresponsible in their administration; and redress in case of injustice or oppression became more and more difficult to obtain. "The diet of the nation," says the historian Johann von Müller, "consisted of those men of whom the nation had chiefly to complain; and in the Court of the Imperial Chamber sat assessors who were maintained by these men. Under the name of German liberty an aristocratic rule, hurtful to the nation, was established."

Alterations in the diet.

The diet of the empire also entirely changed its character. It had been an assembly held at uncertain intervals, and attended by the princes in person, under the presidency of the emperor. It now became a permanent congress, to which the various principalities only sent deputies or representatives. The meeting-place was fixed at Regensburg (Ratisbon); and the institution, though in an entirely effete and weak condition, continued until the final dissolution of the empire in 1806. When at the meetings of the diet the emperor no longer appeared in person, but was represented by his commissaries, while the estates were present through their deputies only, the institution itself lost all its former importance and reverrence. The time at the meetings was consumed in regulating trifles of precedence and rank and title: questions as to what deputies were entitled to be addressed as "your excellency," and whether some deputies had not a right to be seated on red-embroidered chairs while the rest were accommodated with seats of modest green, and whether these chairs were to be set *upon* or only at the *edge* of the carpet beneath the canopy; who was to take the right-hand seat; in what order the toasts were to be proposed at the banquets, etc. And this while the Turks were threatening and even invading the empire on the one side, while the aggressive and ambitious policy of Louis XIV. menaced it on the other. Thus, in a period when political existence depended upon union and on combined action, the various states of Germany, and even the representatives of the various classes, were arrayed against each other. Various great cities, such as Bremen, Magdeburg, Brunswick, Munster, were forcibly deprived of their liberties; and law and justice were alike disregarded where the interests of the ruling classes were concerned.

Frivolous discussions.

The long reign of Leopold I. (1658—1705) is characterized by two great struggles—against France, and against the Turks. Leopold was only seventeen years old when his father, Ferdinand III., died, in 1657; and Mazarin tried hard to procure the imperial crown for his master, Louis XIV.; and succeeded in exacting great sacrifices from Austria, and in uniting various German potentates, such as the electors of Bavaria, the three ecclesiastical electors of Cologne, Treves and Mayence, and others, into a Rhenish league under the protectorate of France. In the struggle against France Leopold was generally unsuccessful, through the divided counsels among the princes, and the venality of various rulers and ministers, who sold the interests of their country for the gold of Louis XIV. Thus Prince Lobkowitz, the minister of Leopold, was in reality a partisan of the French monarch; and Leopold himself, a pupil of the Jesuits (he had been originally intended for the Church), and a slow, undecided man, was unable to improve advantages where he gained them, or to lessen the evil consequences of defeat by judicious and prompt arrangements. When Louis XIV. entered upon the great war which was intended to ruin Holland, Leopold at length, becoming alive to the disastrous effects the supremacy of the French king would have upon the empire, allied himself with Holland and Spain, and took part in the contest that raged from 1672 to 1678 and was concluded by the treaty of Nimeguen. It was during this period that Turenne sullied the fame of his great achievements by the inhuman devastation of the palatinate, of Alsace, and of Lorraine. The exertions and genius of Montecuculi, his general, for a time won various successes for Leopold, especially after the fatal cannon-ball at Salzbach put an end to Turenne's career, in 1675; but the treaty of Nimeguen was disastrous to Leopold, who was obliged to cede Freiburg and various other important towns.

Reign of Leopold I.

Leopold's contest with France.

The period that immediately followed the treaty of Nimeguen is one of humiliation and loss alike for the German empire and for the Spanish monarchy. Then it was that Louis XIV., conscious of his own strength and of the weakness of his foes, established those "chambres de réunion" whose office it was to give him a pretext for setting up a claim to various towns and territories, on the ground that they had at some period or other belonged to his kingdom. In these matters the French king was at once plaintiff, judge, and executor; the tribunals were merely nominal, for their verdict was always for Louis. He also, in 1681, suddenly seized on Strasburg, and demanded that Alost, in Flanders, should be given up to him, declaring that his ministers had forgotten to insert it in the treaty. There was no limit to his arrogance at this the most prosperous point of his career. In 1684 a truce for twenty years was agreed upon, by which Louis retained all the territories awarded to him by the reunion chambers.

Humiliation of Germany by France.

From the year 1606 until 1658 peace was maintained between Austria and Turkey, but in the last-mentioned year a quarrel arose with respect to Siebenbürgen, whose prince,

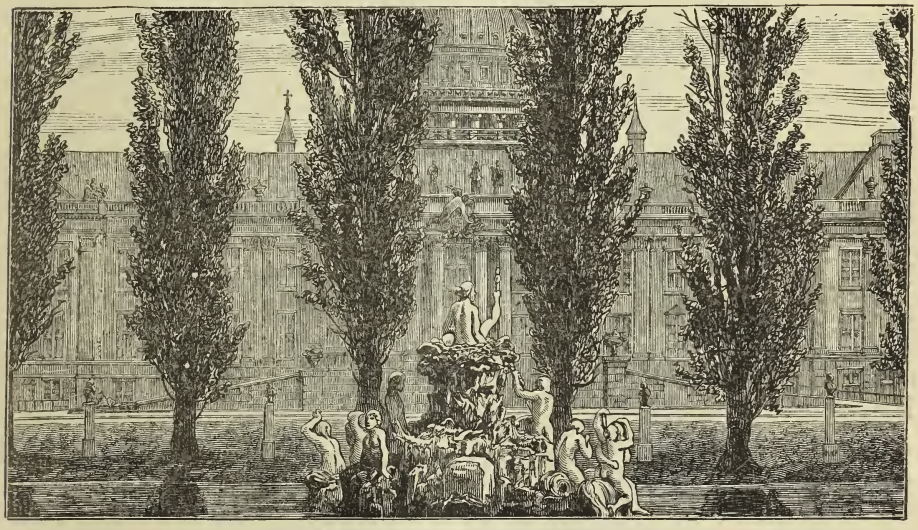
Austria and the Turkish empire.

chosen by the Estates, was alike under the protection of Austria and the Porte. For some time negociations continued, but at length, in 1663, a formal declaration of war was issued by Turkey, after hostilities had been carried on for some time. At first the Porte had the advantage; but when at last the diet, aroused by the danger, accorded large help to the emperor in men and money, Montecuculi, Leopold's general, gained a great victory over the Turks by the convent of St. Gotthart, on the banks of the Raab. Whereupon peace was made.

Victory of the Raab.

This peace, however, was looked upon with great disfavour by the Hungarians, who had assisted in putting down the Turks, and now found themselves excluded from all share in the treaty. The consequence of this discontent was a revolt of Hungary, which was put down by Austria, and afterwards punished with great severity, and even cruelty; many who had no hand in it being made to suffer for the faults of others. The opportunity was especially taken for a general persecution of the Protestants, and the liberties of Hungary were declared forfeit. This policy rekindled the flames of revolt. Under a noble named Tökely a formidable insurrection was organised; and the increased severities of the Austrians, who put their prisoners to death by gallows and wheel, called forth reprisals on the part of the rebels; and such horrors were perpetrated that the Austrian government, seeing how both Turkey and France were ready to take advantage of this disastrous state of affairs, made at least an endeavour towards pacification by granting some religious and political concessions. The position of Austria with regard to Turkey, whose rulers were continually menacing its frontiers, was one great cause of the frequent discomfiture of that power, in its efforts to assert supremacy in Germany and against France.

Tökely's revolt in Hungary.



POTSDAM, THE PALACE OF FREDERICK THE GREAT.

XLIII.

Practical Application.

(1) VOCABULARY XXI.

Légumes et Herbes potagères (*Vegetables and Kitchen Herbs*).

ail,* *garlic*
artichaut, *artichoke*
asperge, *asparagus*
aubergine, *madapple*
betterave, *beetroot*
brocoli, *broccoli*
carde, *sea-kale*
carotte, *carrot*
céleri, *celery*
cerfeuil, *chervil*
champignon, *mushroom*
chicorée, *endive*
——— sauvage, *dandelion*
chou,† *cabbage*
choucroute, *saurkraut*
chou de Bruxelles, *B. sprout*
chou-fleur, *cauliflower*
chou-rave, *rapecole*
citrouille,‡ *pumpkin*
cive } *chives*
civette }
ciboulette }
concombre, *cucumber*
cornichon, *gherkin*
courge, *gourd, pumpkin*
——— à la moelle, *veg. marrow*
cresson, *cress*
——— de fontaine, *watercress*
cumin, *cummin*
échalotte, *shalots*
épinards, *spinach*
fève, *bean*
—— de marais } *horse-*
fèverole } *bean*
fines herbes, *sweet herbs*
flageolet, *fine species of kidney bean*
haricot, *kidney-bean*
——— d'Espagne, *scarlet-runner*
——— vert, *French bean*
laitue, *lettuce*
——— pommée, *cabbage-lettuce*
lentille, *lentils*
mâche, *corn-salad*
marjolaine, *marjoram*
melon,§ *melon*

* All nouns here ending in *e* mute, with one exception, are feminine; those ending in a consonant and *concombre* are masculine.

† Both *chou* and *chou-chou* are also terms of endearment to children.

‡ In popular language, *citrouille*, *cornichon*, *melon*, are synonymous terms to *stupid*.

§ Fruit or vegetable taken as an *entrée;* principal varieties *cantaloup* and *sucrin*. Water-melon=*pastèque* or *melon d'eau*.

menthe, *mint*
navet, *turnip (elongated)*
oignon, *onion*
oseille, *sorrel*
panais, *parsnip*
persil, *parsley*
poireau, *leek*
pois, *pea*
—— cassé, *split-pea*
petits pois, *green-peas*
pois chiche, *chickpea*
—— goulu } *sugar or*
—— mange-tout } *Wyker pea*
pomme de terre, *potato*
potiron, *pumpkin*
radis, *radish*
raifort, *horse-radish*
rave, *turnip (round)*
romaine, *cos-lettuce*
salade, *salad*
salsifis, *salsify*
sauge, *sage*
thym, *thyme*
tomate, *tomato*
topinambour, *Jerusalem artichoke*
truffes, *truffles*
turnep, *swede*
vitelotte, *kidney-potato*

(2) Model of a Reflective Verb.

INFINITIVE.

Present. s'écrier, *to exclaim*
Past. s'être écrié, *to have exclaimed.*

PARTICIPLE.

Present. s'écriant, *exclaiming*
Past. écrié, *exclaimed;* s'étant écrié, *having exclaimed*

INDICATIVE.

Present.	*Perfect Indefinite.*
je m'écrie	je me suis écrié
I exclaim	*I have exclaimed*
tu t'écries	tu t'es écrié
il s'écrie	il s'est écrié
elle s'écrie	elle s'est écriée
nous nous écrions	nous nous sommes écriés
vous vous écriez	vous vous êtes écriés
ils s'écrient	ils se sont écriés
elles s'écrient	elles se sont écriées
Imperfect.	*Pluperfect.*
je m'écriais	je m'étais écrié
I was exclaiming	*I had exclaimed*
tu t'écriais	tu t'étais écrié
il s'écriait	il s'était écrié
nous nous écriions	nous nous étions écriés
vous vous écriiez	vous vous étiez écriés
ils s'écriaient	ils s'étaient écriés
Perfect Definite.	*Perfect Anterior.*
je m'écriai	je me fus écrié
I exclaimed	*I had exclaimed*
tu t'écrias	tu te fus écrié
il s'écria	il se fut écrié
nous nous écriâmes	nous nous fûmes écriés
vous vous écriâtes	vous vous fûtes écriés
ils s'écrièrent	ils se furent écriés
Future Absolute.	*Future Anterior.*
je m'écrierai	je me serai écrié
I shall exclaim	*I shall have exclaimed*
tu t'écrieras	tu te seras écrié
il s'écriera	il se sera écrié
nous nous écrierons	nous nous serons écriés
vous vous écrierez	vous vous serez écriés
ils s'écrieront	ils se seront écriés

CONDITIONAL.

Present or Future.	*Past.*
je m'écrierais	je me serais écrié
I should exclaim	*I should have exclaimed*
tu t'écrierais	tu te serais écrié
il s'écrierait	il se serait écrié
nous nous écrierions	nous nous serions écriés
vous vous écrieriez	vous vous seriez écriés
ils s'écrieraient	ils se seraient écriés

Other form for the Past.

je me fusse écrié
tu te fusses écrié
il se fût écrié
nous nous fussions écriés
vous vous fussiez écriés
ils se fussent écriés

IMPERATIVE.

écrie-toi, *exclaim (thou)*
qu'il s'écrie, *let him exclaim*
écrions-nous, *let us exclaim*
écriez-vous, *exclaim (ye)*
qu'ils s'écrient, *let them exclaim*

SUBJUNCTIVE.

Present.	*Perfect Definite.*
que je m'écrie	que je me sois écrié
that I may exclaim	*that I may have exclaimed*
tu t'écries	tu te sois écrié
il s'écrie	il se soit écrié
nous nous écriions	nous nous soyons écriés
vous vous écriiez	vous vous soyez écriés
ils s'écrient	ils se soient écriés
Imperfect.	*Pluperfect.*
que je m'écriasse	que je me fusse écrié
that I might exclaim	*that I might have exclaimed*
tu t'écriasses	tu te fusses écrié
il s'écriât	il se fût écrié
nous nous écriassions	nous nous fussions écriés
vous vous écriassiez	vous vous fussiez écriés
ils s'écriassent	ils se fussent écriés

(3) Model of a Reflective Verb, conjugated negatively.

INFINITIVE.

Present—ne pas se punir, *not to punish oneself.*
Past—ne s'être pas puni, *not to have punished oneself.*

PARTICIPLE.

Present—ne se punissant pas, *not punishing oneself.*
Past—puni, *punished;* ne s'étant pas puni, *not having punished oneself.*

INDICATIVE.

Present.	*Perfect Indefinite.*
je ne me punis pas	je ne me suis pas puni
I do not punish myself	*I have not punished myself*
tu ne te punis pas	tu ne t'es pas puni
il ne se punit pas	il ne s'est pas puni
nous ne nous punissons pas	nous ne nous sommes pas punis
vous ne vous punissez pas	vous ne vous êtes pas punis
ils ne se punissent pas	ils ne se sont pas punis
Imperfect.	*Pluperfect.*
je ne me punissais pas	je ne m'étais pas puni
I was not punishing myself	*I had not punished myself*
Perfect Definite.	*Perfect Anterior.*
je ne me punis pas	je ne me fus pas puni
I did not punish myself	*I had not punished myself*
Future Absolute.	*Future Anterior.*
je ne me punirai pas	je ne me serai pas puni
I shall not punish myself	*I shall not have punished myself*

CONDITIONAL.

Present or Future.	*Past.*
je ne me punirais pas	je ne me serais pas puni
I should not punish myself	*I should not have punished myself*

IMPERATIVE.

ne te punis pas, *do (thou) not punish thyself*
qu'il ne se punisse pas, *let him not punish himself*
ne nous punissons pas, *let us not punish ourselves*
ne vous punissez pas, *do (ye) not punish yourselves*
qu'ils ne se punissent pas, *let them not punish themselves*

SUBJUNCTIVE.

Present.	*Perfect Definite.*
que je ne me punisse pas	que je ne me sois pas puni
that I may not punish myself	*that I may not have punished myself*
Imperfect.	*Pluperfect.*
que je ne me punisse pas	que je ne me fusse pas puni
that I might not punish myself	*that I might not have punished myself*

(4) Model of a Reflective Verb conjugated interrogatively.

(*Two moods only can be so conjugated.*)

S'apercevoir, *to notice.*

INDICATIVE.

Present.	*Perfect Indefinite.*
m'aperçois-je?	me suis-je aperçu?
do I notice?	*have I noticed?*
t'aperçois-tu?	t'es-tu aperçu?
s'aperçoit-il?	s'est-il aperçu?
s'aperçoit-elle?	s'est-elle aperçue?
nous apercevons-nous?	nous sommes-nous aperçus?
vous apercevez-vous?	vous êtes-vous aperçus?
s'aperçoivent-ils?	se sont-ils aperçus?
s'aperçoivent-elles?	se sont-elles aperçues?
Imperfect.	*Pluperfect.*
m'apercevais-je?	m'étais-je aperçu?
was I noticing?	*had I noticed?*
Perfect Definite.	*Perfect Anterior.*
m'aperçus-je?	me fus-je aperçu?
did I notice?	*had I noticed?*

Future Absolute.	*Future Anterior.*
m'apercevrai-je? *shall I notice?*	me serai-je aperçu? *shall I have noticed?*

CONDITIONAL.

Present or Future.	*Past.*
m'apercevrais-je? *should I notice?*	me serais-je aperçu? *or* me fussé-je aperçu? *should I have noticed?*

(5) MODEL OF A REFLECTIVE VERB CONJUGATED INTERROGATIVELY AND NEGATIVELY.

(*Two moods only can be so conjugated.*)

Se rendre, *to betake oneself.*

INDICATIVE.

Present.	*Perfect Indefinite.*
*est-ce que je ne me rends pas? *do I not betake myself?*	ne me suis-je pas rendu? *have I not betaken myself?*
ne te rends-tu pas?	ne t'es-tu pas rendu?
ne se rend-il pas?	ne s'est-il pas rendu?
ne se rend-elle pas?	ne s'est-elle pas rendue?
ne nous rendons-nous pas?	ne nous sommes-nous pas rendus? [rendus?
ne vous rendez-vous pas?	ne vous êtes-vous pas
ne se rendent-ils pas?	ne se sont-ils pas rendus?
ne se rendent-elles pas?	ne se sont-elles pas rendues?

* The emphatic form of interrogation is here required because the verb only appears with one syllable in this person (see p. 6, vol. II.). It will also be remembered that every person of every tense may always be conjugated with *est-ce que;* thus:—

Present.	*Perfect Indefinite.*
est-ce que je ne me rends pas? *do I not betake myself?*	est-ce que je ne me suis pas rendu? [*self?* *have I not betaken my-*
est-ce que tu ne te rends pas? [pas?	est-ce que tu ne t'es pas rendu? [rendu?
est-ce qu'il ne se rend	est-ce qu'il ne s'est pas
est-ce qu'elle ne se rend pas?	est-ce qu'elle ne s'est pas rendue?
est-ce que nous ne nous rendons pas?	est-ce que nous ne nous sommes pas rendus?
est-ce que vous ne vous rendez pas?	est-ce que vous ne vous êtes pas rendus?
est-ce qu'ils ne se rendent pas?	est-ce qu'ils ne se sont pas rendus?
est-ce qu'elles ne se rendent pas?	est-ce qu'elles ne se sont pas rendues?

Imperfect.	*Pluperfect.*
ne me rendais-je pas? *was I not betaking myself?*	ne m'étais-je pas rendu? *had I not betaken myself?*
Perfect Definite.	*Perfect Anterior.*
ne me rendis-je pas? *did I not betake myself?*	ne me fus-je pas rendu? *had I not betaken myself?*
Future Absolute.	*Future Anterior.*
ne me rendrai-je pas? *shall I not betake myself?*	ne me serai-je pas rendu? *shall I not have betaken myself?*

CONDITIONAL.

Present or Future.	*Past.*
ne me rendrais-je pas? *should I not betake myself?*	ne me serais-je pas rendu? *or* ne me fussé-je pas rendu? *should I not have betaken myself?*

EXERCISE LIII.

1. He exclaims; they were exclaiming; we exclaimed. 2. Mary (*Marie*). thou didst exclaim (*perf. def.*); ladies (p. 403, vol. II.), you did exclaim (*do.*); she must (it is necessary = *il faut*, that she may) exclaim; they must (it is necessary that they may) have exclaimed. 3. She does not punish herself; those nuns (*religieuses*) had not punished themselves. 4. Thou must not (it is not necessary = *il ne faut pas*, that thou mayest) punish thyself; thou wast not to (it was not necessary = *il ne fallait pas*, that thou mightest) punish thyself. 5. Am I noticing? wast thou noticing? shall we notice? 6. Would you notice it (of it = *en*)? have I noticed it (of it = *en*)? will she have noticed them (of them = *en*)? 7. Do they not betake themselves? have they not betaken themselves? 8. Do we not betake ourselves to it (*y*)? have we not betaken ourselves to London (*à Londres*)? 9. She leans on her elbow; she will not have leaned on her elbow. 10. We squat; we do not squat here. 11. He will wend his way to the town as usual (*vers la ville comme de coutume*); will you not wend your way to the town as usual? 12. The children knelt before the bishop (*devant l'évêque*); the priest (p. 590, vol. I.) was kneeling before the altar (*autel*). 13. He stopped for-a-moment (*un instant*) at the summit of the hill (*sommet*, m., *colline*, f.); did he stop long there (*longtemps, y*)? 14. They slumber peacefully (*paisiblement*); one who (*quelqu'un qui*) never (*jamais* after the verb) slumbers. 15. The citizens (*citoyens*) flock together, and wonder what is bringing Regulus from Carthage (*ce qui amène Regulus de Carthage*). 16. I expect it (to it = *y*); do you think (*croyez-vous*) that I was not expecting it (to it = *y*)? 17. We bathe every day (*tous les jours*); they were bathing every second day (*tous les deux jours*); you must (it is necessary = *il faut*, that you may) bathe every third day. 18. The horse reared; he had just detected (*venait de découvrir*) a panther crouching (*une panthère qui* was crouching) in the fork of a (*dans la fourche d'un*) tree. 19. She attends confession once a fortnight (*une fois tous les quinze jours*). 20. The wall (*la muraille*) gives way; the navvies endeavour to (*terrassiers essayent de*) escape; a short time (*quelque temps*) elapses; a great anxiety (*une vive inquiétude*) seizes upon us.

EXERCISE LIV

1. The pumpkin is sold by-weight (*au poids*). 2. How (*comment*) is asparagus sold? it (*elles*) is sold in bundles (*en bottes*) 3 Our potatoes have not sold well; indeed, nothing was selling to-day (*du reste rien ne . . . aujourd'hui*). 4. (The) green peas are selling cheap (*à bon marché*); but (the) French beans are selling very-dear (*bien cher*). 5. Artichokes are eaten in several ways (*de plusieurs manières*); they are eaten with-a-white-sauce (*à la sauce blanche*), fried-in-olive-oil (*à la barigoule*); with-pepper-salt-and-vinegar (*à la poivrade*) in-the-Provençal-fashion (*à la provençale*). 6. Cabbage is (cabbages are) eaten with (some) bacon (*lard*, m.) 7. The spinach will-be-more-savoury (will be eaten better) if you add (to them = *y*) a few sorrel leaves (*quelques feuilles de . . .*). 8. Your celery will not keep long if you do not cover it better (*longtemps si vous ne le couvrez pas mieux*). 9. Do you think (*croyez-vous*) that those vegetables are (*may be*) found in (*au*) Canada? 10. Turnips do not keep (*se conserver*) this winter (*cet hiver*). They will keep better if this frost keeps up (*s'il continue à geler*). 11. There (*là*) are to be seen whole

fields (*des champs entiers*) of (*d'*) asparagus, (of) sea-kale, (of) salsify, and (of) artichokes. 12. How is that plant (*plante*, f.) called? It is called (some) chives. 13. Cauliflower is (the cauliflowers are) served hot or cold, with a white sauce, done brown, or with-a-pepper-salt-oil-and-vinegar-sauce (*chauds ou froids, à la sauce blanche, au gratin, ou à la vinaigrette*). 14. To go and plant cabbage (*aller planter ses . . .*) is said metaphorically (*par métaphore*) of a man who retires to the country (*se retirer à la campagne*). 15. Will he never be cured of his passion (f.) for truffles? He will never be cured of it; he orders some for every meal (*il s'en fait servir à tous les repas*). 16. Mushrooms are prepared in many ways (*se préparer, de beaucoup de manières*). 17. Not to know the difference between (*ne pas connaître la différence entre la*) plain lettuce and cos-lettuce is not *to be* forgiven. 18. For a long time people were content with gathering the (*pendant longtemps on, se contenter, de recueillir le*) cresses (sing.) which were found in a wild state (*à l'état sauvage*). 19. Watercresses are easily propagated (*se propager, facilement*) by seeds or sprays (*par graines ou par éclats*). 20. Raw cresses (*le . . . cru*) is easily digested (*se digérer, facilement*) with broiled or roasted meats (*viandes grillées ou rôties*). 21. Every (*tout*) mushroom is composed (*se composer*) of two parts, the one below and the other above ground (*parties, l'une souterraine, l'autre aérienne*).

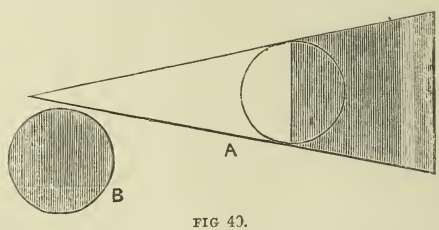


FIG 40.

VIII.

LIGHT.

THE science of Optics or Light forms the most interesting, though perhaps at the same time the most difficult, branch of physics; but whatever opinions may be held as to its difficulty, there can be no doubt as to its fascinating beauty and interest.

What is light?

The most natural inquiry of the student just commencing his studies in this branch of science is as to the nature and cause of the condition of matter the laws of which he is about to investigate. To the inquiry, "What is light?" no fully satisfactory reply can be given upon the threshold of our studies, but it is necessary that we should know something of the elementary facts and phenomena of the science before we are enabled to judge of the value of the hypothesis by which those phenomena are supposed to be explained. In order, however, that some general notion of the nature of light should, even at the outset, be possessed by our readers, we will give here a brief and general outline of the now generally accepted theory of light, leaving to a later period of our studies the detailed examination and discussion of that hypothesis.

Light is motion.

According to a theory which is now almost universally accepted, light is the expression of the extremely rapid motion of the molecules of all luminous bodies. Our lamps, our gas, our electric lights, the distant sun and the yet more distant stars, we believe to be in a constant state of molecular vibration, and we have reasons for believing that it is this state of incessant vibration, this condition of constant unrest, which alone causes them to emit light. It is necessary, however, in order that light may be perceived, that some medium should exist for its propagation from luminous bodies to our eyes and the eyes of other animals, which are the special organs prepared by nature for its reception. We therefore believe, or rather suppose, that there exists through all space an extremely rare and highly elastic gaseous or ultra-gaseous medium which is known as "ether"; this ether extends to the most distant of the heavenly bodies, surrounds all substances upon the earth, and penetrates transparent media, including the humours of the eye. This "luminiferous" ether takes up the vibrations of luminous bodies, and conveys them by an undulatory motion to the back of the eye, where is spread out a delicate screen, the "retina," upon which the waves of light are focussed. This screen is an expansion of the nerve of sight, and by the fibres of this nerve the undulations are conveyed to the brain, where, by some process of which we, at present, have no conception, they are translated into sight and vision.

Comparison between sound waves and light waves.

We see by the foregoing statement that there is a somewhat close analogy between the nature of sound and the nature of light, and also between the propagation of sound through air and light through the luminiferous ether. It must, however, be clearly understood that the vibrations of luminous bodies are almost infinitely more rapid than those of sonorous bodies, and also that while the sonorous vibrations are *in* the direction of their line of propagation—that is, are *longitudinal*,—the luminous vibrations are *across* the line of propagation—that is, are *transverse*; the luminous waves consequently in this sense resemble water waves.

Extreme rapidity of luminous vibrations.

In order that the enormous difference in rapidity between the vibrations of sound and those of light may be thoroughly appreciated, and also in order that the foregoing outline of the undulatory theory of light may be more perfectly understood, we venture to trouble our readers with the following further explanation. From common observa-

tion, and from what has been said in this work, in the chapters on "Sound," our readers are all aware that bodies, when they emit a sound, are in a state of vibration. To take such a common musical instrument as a piano or harp: we all know that the sounds of these instruments are produced by the striking or plucking of certain stretched strings which are thus thrown into rapid vibration, and if we watch the strings as they vibrate, we can plainly see their tremulous motion. As is also known, the string giving, when struck, the middle C of the piano, vibrates at the rate of about 256 times in a second. Let us suppose that we have the means of increasing infinitely the rate of vibration of such a string: as the vibrations increase in rapidity the note rises in pitch, until, when the vibrations reach the number of about 40,000 per second, it ceases to produce a sound audible to human ears, this rate of vibration being beyond the extreme upper limit of hearing as exercised by the human ear. Now let the vibrations be still further increased in rapidity, until they reach the number of about four hundred and fifty-one millions of millions in a second of time: they would give out no sound which even the most acute ear could perceive, although the undulations, which are far too rapid to affect our auditory organs, are capable of being appreciated by our more delicate organs of sight, and the string would emit, not a sound, but a *reddish light*; whilst if the vibrations were increased to about seven hundred and eighty-nine millions of millions in a second, the light emitted would be violet. Light, then, like sound, and, as we shall subsequently find, heat —is *motion*, and there is sober truth as well as poetic beauty in Shakespeare's lines when he bids us see—

Analogy between sound and light.

> "how the floor of heaven
> Is thick inlaid with patines of bright gold,"

and tells us that

> "There's not the smallest orb which thou beholdest,
> But in his motion like an angel sings,
> Still quiring to the young-ey'd cherubims:
> Such harmony is in immortal souls;
> But whilst this muddy vesture of decay
> Doth grossly close it in, we cannot hear it."

Possessed of a general idea of the nature of light, and of the method of its propagation, we may now proceed to notice some of the elementary facts of the science. With reference to sources of light, our space being limited, we need say but little. Our ordinary natural sources of light are, of course, the sun and the other heavenly luminaries, while our artificial sources of light consist of candles, various oils, gas, and the electric spark. In addition to these light may be produced by the combustion of the metal magnesium, and by the crushing of loaf sugar in the dark. For a description of the nature of combustion, by which light is usually artificially produced, we must refer our readers to the chapters on "Heat," whilst a full description of the electric light will be found in the papers on "Voltaic Electricity."

Sources of light.

One of the most familiar facts concerning light is that it is always propagated in straight lines. Any one who has ever seen the sun's rays coming from behind a cloud needs no further demonstration of this fact. From it, however, many curious and interesting phenomena flow; and first we will consider its influence in the production of shadows.

Rectilinear propagation of light.

If an opaque body be illuminated by a luminous point, the shadow behind it will be in the shape of a cone, and will be sharply defined; that is to say, if we were to construct a hollow cone and place it exactly half over a sphere illuminated by a luminous point, the cone would represent the space behind the sphere which would be in total darkness—would constitute what is known as the "shadow-cone." Obviously, if a screen were placed so as to intersect this shadow-cone there would be formed upon it a dark circle (*See* fig. 40, A and B.)

Nature of shadows.

If, however, instead of having a point of light we are dealing with a luminous surface, the shadow-cone will no longer be sharply defined, but will consist of a central nucleus termed the "umbra," or true shadow, surrounded by a space partially illuminated, and termed the "penumbra," or partial shadow.

The umbra and the penumbra.

The production of a sharply-defined shadow, and of a shadow surrounded by a penumbra, may be illustrated by a very simple experiment. Take any flat-flame, such as that of a paraffin lamp, or a "bat's-wing" gas-burner, and hold between it and a piece of white paper an ordinary lead pencil or similar object. First arrange your pencil and screen so that the former is illuminated by the *edge* of the flame: a sharply-defined image of the pencil will be formed upon the paper. Now alter the arrangement so that the whole flat surface of the flame illuminates the pencil: the shadow will be seen to consist of two parts—a central dark nucleus, surrounded by a less dark and ill-defined penumbra. It will be further noticed that if the pencil be moved away from the screen the penumbra gradually encroaches upon the nucleus and eventually effaces it, ultimately itself becoming too faint to be visible; this explains how it is that an illuminated hair, when held close to a screen, casts a sharply-defined shadow, but when removed a little distance ceases to cast a shadow at all.

The nature of the penumbra and of the true shadow also depends upon the relative size of the luminous and opaque bodies. If the opaque body be the smaller, the true shadow is a converging cone, while the penumbra is a diverging cone; when both opaque and luminous spheres are of the same size, the shadow is a sharply-defined cylinder; while if the opaque sphere be the larger, both umbra and penumbra are diverging cones. The shadows cast in space by the celestial bodies are of the first kind, and our readers will only require a brief reminder to call to their minds the fact that it

Shadows cast by the heavenly bodies.

is these shadows which cause eclipses—the moon's shadow falling upon the earth producing a solar eclipse, the earth's shadow falling upon the moon producing a lunar eclipse.

XXXII.

The Rhinoceros Family.

In the rhinoceroses we have animals whose bulk, ungainliness, apparent impenetrability by ordinary weapons, and peculiar horn or horns, have long attracted attention. The rhinoceros belongs to the odd-toed division, possessing three nearly equal digits, the second, third, and fourth, on all four feet, each being encased with a comparatively small hoof. The weight of the body is largely supported upon dense skin-pads beneath the long bones of the feet, which are distinct, and not lengthened as in the horse. The skin over the whole body is remarkably thick and dense, and it has but a scanty amount of hair. It has been commonly believed that the skin was impervious even to rifle bullets; but this is untrue. Sharp swords are also available in attacking this mailed creature, which is protected to a considerable extent by its speed, wherein it surpasses a very fleet and sturdy horse. When it has reached the jungle the rhinoceros is safe; if it turns to bay, one hunter can engage its attention in front, while others hamstring it.

Toes.

Skin.

The famous horns are not bony, but are, in effect, long, agglutinated, dense, horny masses of hairs developed upon the skin, covering the large nasal and frontal bones. Four feet is about the greatest known length of a rhinoceros horn, and eighteen inches to two feet an average length; about half the species have two horns, and in these the hinder horn is considerably shorter than the front one. The species are almost equally distributed between Africa and the Indo-Malayan geographical territories. Several of the species eat grass, plucking it with their flexible upper lips; some species eat no other food, as far as observed; others also eat rough, prickly leaves and small branches of shrubs. The Asiatic species are notable for their skin-folds, which indent the sides of the body with great grooves, marking out the skin into distinct plots.

Horns.

Food.

The rhinoceros peculiar to India finds use for its horns in displaying its bitter hostility to elephants; there is no doubt that the latter are not unfrequently killed by the rhinoceros by means of its horns. The size of the brute, which sometimes reaches to twelve feet long and nearly six feet high, is sufficient to make its momentum enormous as it butts forward at a great pace; but the horns, wielded by its tremendous neck muscles, are its most formidable weapons.

Ferocity and power.

In the teeth of the rhinoceros there is a striking mark of the herbivorous character in the total absence of canines or "eyeteeth"; the front teeth, too, the incisors, are few or absent in each jaw. The grinders, of which there are seven in each jaw, are massive, but less complicated than in the horse. The stomach is not remarkable; but the first part of the large intestine is immensely developed.

Teeth.

The rhinoceros was long regarded as the unicorn of Scripture; but it is probable that we should understand that the powerful wild ox, then common in Palestine, is meant; two horns are clearly ascribed to it in Deut. xxxiii. 16, 17. The rhinoceros was known in Europe before the Christian era; but specimens were not common in captivity in the last century. It is found that the great creature lives in captivity in good health for many years. Begum, the most valuable animal possessed by the London Zoological Society, belongs to the rare species called "hairy-eared," and came from near Chittagong in 1868. Her value, as the only specimen of the kind that has been carefully observed, is far in excess of that of any elephant.

The unicorn of Scripture.

Begum.

The Tapirs.

The Tapirs present another strange problem in the geographical distribution of animals, for two species range over South America, while one is found in Sumatra, Malacca, and south-west China. The hind feet, with three toes, keep to the plan of the odd-toed group: while the fore feet have four digits, the first (answering to our thumb) being absent; the fifth, however, does not reach to the ground. There is a complete set of incisor and canine teeth, the latter being small. The nose is prolonged into a short but active and useful trunk, by which it feeds. Its diet consists of a rather wide selection of vegetable food, such as is found in forests, where it usually roams by night. Its form is compact and massive, and its power, especially in penetrating the jungle, is great; it cannot be described as specially ferocious. The American tapir has but little hair, but there is a short bristly mane on the top of the head and neck.

Distribution.

Trunk.

The Even-Toed Ungulates.

A well-marked habit, with which is associated a particular construction of stomach, divides this large group into two—those which "chew the cud," or return it to the mouth after it has been once swallowed, in order to prepare it more thoroughly for digestion—the Ruminants,* and those which do not—the Non-ruminants. Among existing animals the latter include the pig and the hippopotamus. All are essentially vegetable eaters.

Ruminants and non-ruminants.

The Pig Family.

The Pigs have two long digits (the third and fourth) and two short ones, which do not reach

* *Ruminant*, chewing the cud.

the ground (the second and fifth). The skin, much thinner than in the rhinoceros and tapir, is well provided with bristly hairs. The grinding teeth are considerably knobbed; but the canines are prominent, especially in the males. They grow for a long time, and are directed outwards and upwards in both jaws, being enabled to work upon one another. The short, stumpy, sensitive snout, is another indispensable possession, with which roots and nuts can be scented and rooted up; its normal feeding time is the dusk and darkness of the evening.

Feet, skin, and teeth.

The pigs proper are absent, as natives, from the New World, Australia, South Africa, and the northern parts of the Old World; it is thus evident that they prefer temperate or tropical climates. In Central and South Africa and Madagascar, we find several modified forms, including the Wart Hogs. In Borneo and Celebes is the fierce Babiroussa. In South America and in the south of North America the pigs are represented by the Peccaries.

Distribution.

Whether they are truly distinct species or not, numerous forms of hogs are known, occurring in almost all forest regions of the Old World, and have long afforded much sport to hunters from their stubbornness, readiness in meeting attack, strength, and agility. A powerful male boar has an unarmed man at his mercy, and not unfrequently can worst with his tusks an armed man on foot. It has been said that a savage boar in his stronghold is as difficult to oust as the grizzly bear from his winter cave in the Rocky Mountains. In its wild state the sixteenth century seems to have witnessed the extinction of the boar in England, while it still flourished in Ireland in the seventeenth.

The wild boar.

The pig has been domesticated by man for food through long ages, being traced back to times before metal was used for weapons. Certain Oriental races, especially Jews and Mahometans, have shown, and still show, a peculiar repugnance to these animals. They were excluded from use for food by Moses, among other creatures which did not chew the cud. Beyond all other animals used for food, these seem to possess in the highest degree the capacity for being fattened, and selection by man has influenced their form and size enormously.

Dislike to pigs.

In the male Babiroussa, which is very savage, the canines in the upper jaw are curved almost into a circle, penetrating the upper lip, and turning backwards towards the front of the eyes. The lower jaws have also large curved canines. It is swift, bulky, and very good eating.

Babiroussa.

The Wart Hogs have a peculiar prominence under each eye, giving them their name; they have also, in addition to powerful canines, a very strange conformation of the last grinding tooth on either side in both jaws. This tooth is in adult age finally left alone by the dropping out of the other grinders, and is constituted sometimes of as many as twenty-five distinct columns of dentine arranged in three rows, each coated by enamel, all being combined into one tooth by tooth-bone or "cement."

Wart hogs.

The Peccaries are small but active members of the pig family, affording in no sense mean game to the sportsman; they exhibit a feature of difference from the pigs in having the long bones of the third and fourth digits united into a single bone like a cannon bone.

Peccaries.

It is interesting to note that in these non-ruminants there is a gradual approach to the complex stomach of the ruminants. The hogs have a slight division of the stomach into two regions. In the babiroussa and the peccaries the stomach is divided into three chambers.

Stomach of pigs.

The Hippopotamus.

This huge creature, the Behemoth of the Book of Job, is one of those long placed in a group of amphibious creatures, which, however, do not correspond to a true zoological group. We now know that many different orders include animals which spend much time in water as well as on land. The term amphibious is now used for denoting these animals which at one period of their existence are adapted to breathe air dissolved in water, and at another the air of the atmosphere. In one sense the hippopotamus may be viewed as a great swimming pig, feeding on the coarse grass of the river-side meadows. It attains a weight of several tons, and is remarkable for the length of its skull and the breadth of its fore-part, occasioned by the size of the great tusk-like front teeth, which, with the canines at the corners, form a row of "persuaders" most likely to prove effectual on any enemy, human or animal.

Amphibious creatures.

Bulk and tusks.

Notwithstanding its enormous bulk, and the thick-set short legs, the hippopotamus is a most rapid traveller on land, and its speed in swimming and skill in diving are very considerable. The small nostrils can be kept completely closed during immersion in water; eyes and ears, too, are well adapted for use in the water. The large stomach has four divisions, and can contain, when necessary, half a dozen bushels of food.

Adaptations for water.

The hippopotamus, being so huge, and so ready in taking to the water when pursued, has proved rather a difficult creature to bring into civilised countries. Thus the first of his race to arrive in England came in 1850, and lived in the London Zoological Gardens till 1878. Once arrived, it was not difficult to feed and keep him in good health. This animal was the father of young "Guy Fawkes," born in 1872 in the gardens. They are naturally gregarious, haunting the large rivers of Africa in considerable numbers. Their capture is an affair requiring much skill, and is practised by specially trained hunters. A peculiar harpoon is the favourite weapon. Gunshot is of little avail if the animal can reach the water, for the creature sinks to the bottom and cannot be drawn out; and the

object of hunting is to procure the flesh, which is much liked by many, though an object of aversion to some. The hide furnishes valuable whips, and the tusks are of excellent ivory.

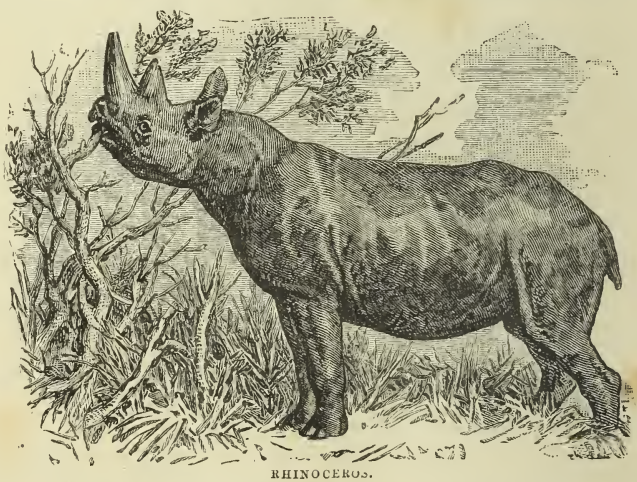
A small species of hippopotamus (the Liberian), not one-sixteenth the size of the other, has a comparatively limited range on the west coast of Africa; it has but two incisors instead of four in the lower jaw.

The Liberian hippopotamus.

The Ruminants.

These include the great bulk of species among the Ungulates. While the other groups, distinctly and strikingly characterized though they be, are represented by comparatively few genera and species at the present time, there are many genera and species of the ruminants; and liable though they are to the attacks of many carnivorous creatures, their powers of multiplication appear to confer on them a distinction in numbers which is only surpassed by the rodent or gnawing group of mammalia. In geological history we find that there has been a continual downward progression from the typical number of forty-four teeth in the adult to thirty-two in the ox, which with most of its group lacks incisor and canine teeth in the upper jaw, while in the lower the pair of canines is turned forwards and ranged with the six incisor teeth. These eight lower teeth bite against a hard pad of the membrane or skin covering the inner surface of the mouth; and this arrangement is admirably adapted for cropping the herbage on which these creatures feed. The grinders are situated a considerable distance behind the front teeth, and the hinder three are larger and more complex than the three in front, which replace milk teeth. Each of the larger teeth consists of two complete portions one behind the other, and each portion has a deep crescent-shaped fold of enamel with the concavity directed outwards in the upper and inwards in the lower jaw. When the teeth are worn, the pattern of the teeth is like that of two double crescents adjacent to one another.

Numbers.



RHINOCEROS.

Teeth.

The character "even-toed" is consistently kept up; the bones of the third and fourth digits being really distinct, and being clothed by two hoofs; but the long bones of the foot or "cannon-bones" are closely united, although there is no case in which it is impossible to trace the two component halves of the bone. At the lower end there are always two distinct joint-surfaces for the two digits.

The hoofs.

The process of rumination has long attracted attention. It is connected with a peculiar subdivision of the stomach into chambers, each of which has a distinct function. The ruminants take in large quantities of herbage rapidly, and the food is at once swallowed and passed into a large left-hand portion of the stomach, the *paunch* or *rumen*, which retains the food-mass undigested, or becoming sodden with saliva, until the animal has finished grazing. At this period it usually lies down, and it may be seen that from time to time a portion of the food previously swallowed is propelled up the gullet into the mouth, where, mixed with more saliva, it undergoes prolonged chewing and pulping. The other portions of the stomach besides the paunch are the *honeycomb*, whose surface is divided into shallow hexagonal cells; the *manyplies*, or many-folded chamber, which has its lining membrane in many folds, which can be separated somewhat like the leaves of a book; and finally the *rennet*, which has a soft glandular membrane, and is the only part which forms a true digestive gastric juice. The manyplies by its structure prevents any but finely pulped food from passing into the true digestive stomach. There are many features of interest about the process of rumination, but it must suffice to mention that the structure of the stomach is contrived so that it is possible to pass the food from the paunch back into the gullet, and on its second return to the stomach to pass it on through the honeycomb to the manyplies and thence into the rennet.

Mode of feeding.

Rumination.

A very large proportion of the Ruminants possess horns, but the horns are not all of similar construction. One principal kind is that in which a bony growth from each frontal bone is permanently covered by a strong layer of "horn" derived from the epidermis. These are called "hollow-horned," and include the oxen, sheep, goats, and antelopes; among the latter group, however, the Prong-horn of central North

Horns.

America sheds the horny sheath every year and grows a new one.

In this hollow-horned group are included many of the most important food-animals for mankind, ranging in countless herds in many quarters of the Old World, and equally numerous in the domesticated state. They are few in species in the New World, although the North American bison is abundant in individuals. Among the more important breeds of domestic oxen are the Hereford, the Shorthorn, the Alderney, the Jersey, and the Devon. The Gaur, the Gayal, the Zebu, are Indian and Oriental species allied to the typical ox. Buffaloes, with a shorter, rounder face than the ox, are widely found over Africa and the Indian region. The Indian buffalo has spread by introduction from Morocco to the extremity of China and to Java. The Cape buffalo extends northwards to Abyssinia. The Aurochs or European bison is now restricted in Europe to the forests of Lithuania and the Caucasus, but formerly extended much more widely. The Yak of Thibet has very long hair reaching to the ground from its shoulders, abdomen, and thighs, and thickly investing the tail.

Wild and domestic cattle.

Buffaloes.

The Antelopes, including the Gazelles, embrace a large number of species characterized by a slender, graceful body, formed for speed. They abound in Africa, and are very numerous in Asia, as far north as Independent Tartary and Mongolia. The gazelles belong to the district connecting Asia and Africa, and are found partly in both.

Antelopes and gazelles.

HIPPOPOTAMUS.

HOW TO ENTER THE CIVIL SERVICE.

III.

Boy Clerkships.

The Lower Division of the Civil Service includes Boy Clerkships. Candidates for these appointments must be over fifteen and under seventeen years of age. The salary commences with 14*s.* per week, and increases at the rate of 1*s.* weekly every year, but no boy clerk is allowed to remain in the service after the age of nineteen, and on reaching that age he will be discharged. All boy clerks, however, whose conduct has been satisfactory, are allowed an opportunity of competing *amongst themselves* for men clerkships (lower division), the number of situations reserved being one-fourth of the number of competitors. If a boy clerk enters the service at the age of fifteen he is not permitted to take part in these "limited competitions" until after two years of good service; if admitted after seventeen years of age, he may do so after one year of good service. The competitive examinations for boy clerkships are advertised in the same way as those for men clerkships, and application to take part in them must be made, as previously explained, after the date has been advertised, in the candidate's own handwriting, to the Civil Service Commissioners, Cannon Row, Westminster. They are open to "all natural-born subjects of Her Majesty, being of the prescribed age, and of good health and character," with the exceptions printed in the General Regulations given in our first article (see pp. 707-8).

The subjects of examination are as follows:—

(1) Handwriting.
(2) Orthography.
(3) Arithmetic, including Vulgar and Decimal Fractions.
(4) Copying MS. (to test accuracy).
(5) English Composition.
(6) Geography.

No candidate will be eligible who does not satisfy the Civil Service Commissioners of his competency in handwriting, orthography, and arithmetic.

The number of persons to be selected at each examination will be published as part of the notice of every such examination; and a list of the competitors will be made out, in the order of merit, up to this published number, if so many are found by the examination to be qualified for appointments in the Civil Service. The examination fee is ten shillings.

As in the case of men clerkships, selections will, as a general rule, be made by the Civil Service Commissioners according to the order of the names on the list; but the Civil Service Commissioners may select any clerk who, in

his examination, has shown special qualifications in any particular subject, if application for such a clerk be made by any department; and no boy clerk will be allowed to retain his appointment unless he proves himself to be competent to the discharge of the duties assigned to him.

The following is a list of the departments to which lower division Boy Clerks have been assigned :—

Admiralty; Charity Commission; Dublin Metropolitan Police Office; Education Department; Lunacy Board (Scotland); Post Office; Registrar-General's Office (Scotland); Board of Trade; Valuation Office (Ireland); War Office (including Army Clothing Department).

Specimens of examination papers can be obtained through the booksellers, and these should be examined by intending competitors for the purpose of gaining a clear idea of the character of the questions likely to be set.

How to Enter as Temporary Copyists in Public Departments.

A register of men and boy copyists for temporary employment in public departments is kept by the Civil Service Commissioners. Examinations for the purpose of testing the qualifications of candidates who wish to be so engaged are held from time to time.

Men copyists must be over eighteen years of age, and the fee for examination is 5*s*. The subjects of examination are—

(1) Handwriting.
(2) Orthography.
(3) Copying manuscript.
(4) Copying figures and tabular statements.

These subjects are obligatory, and only those who show themselves proficient in them can be placed on the register. Candidates may also be examined in arithmetic, but this is an optional subject. Those, however, who do not pass in arithmetic are excluded from employment when copyists are required for arithmetical work.

Boy copyists must be over fourteen and under eighteen years of age, and their examination is confined to—

(1) Handwriting.
(2) Orthography.
(3) Elementary arithmetic.

The examination fee is 2*s*. 6*d*. No boy copyists can be retained as such after reaching the age of nineteen.

Candidates who, having passed the examination, have been put on the register, will be employed in any department just as they may be wanted. When they are not wanted they have no claim to employment. The rate of payment for men copyists is 10*d*. per hour, or 1½*d*. for every hundred words. Boy copyists commence at the rate of 4*d*. per hour, increasing ½*d*. per hour every year.

Further particulars respecting these appointments can be obtained by application at the office of the Civil Service Commissioners, and it is only necessary here to remark that they are in no sense stepping stones to higher engagements, and no length of service as copyist confers any claim to superannuation or compensation allowance or pension. It is, however, important to note that successful candidates for lower division clerkships while waiting for appointments will be placed on the register as temporary copyists if they signify their wish to that effect.

Female Clerkships.

The only clerkships at present open to young women are in connection with the postal and telegraph services. This is to be regretted, as there is a constantly increasing number of women who have to get their own living, and who experience great difficulty in finding suitable employment; and there are many situations in other departments of the Civil Service besides those mentioned which might be thus filled to advantage. This was fully admitted by the Commission appointed in 1874 to examine and report on the whole question of Civil Service employment. "We have taken evidence," they reported, "regarding the employment of female clerks. The experience of the post office, as will be seen by the evidence, shows that women are well qualified for clerical work of a less important character, and are satisfied with a lower rate of pay than is expected of men similarly employed. We therefore see no reason why the employment of female clerks should not be extended to other departments where the circumstances will admit of it." With this conclusion we cordially concur, though it seems hard that efficient service should not be paid for according to its intrinsic value irrespective of the sex of the clerk who renders it. It will, however, be a great boon to many when the recommendations of the Commissioners are carried out, and the question of salary must be left to settle itself in due course.

Female clerks are employed in the Receiver and Accountant-General's Office and the Savings Banks department of the General Post Office. The salary attached to these clerkships commences at £65 per year, and increases by £3 annually to £80 with the prospect of promotion. Female clerks are required to resign their appointments on marriage. Candidates must apply to the Civil Service Commissioners, Cannon Row, and they will have to satisfy the Commissioners: 1. That their age on the first day of the competitive examination is not less than eighteen nor more than twenty; but persons already in the service of the post office may, in reckoning their age, deduct any time during which they have served, if such service is continuous. 2. That they are unmarried or widows. 3. That they are duly qualified in respect of health and character.

The preliminary examination—for which a fee of 1*s*. will be required—includes only Handwriting, Spelling, and Arithmetic (including Vulgar and Decimal Fractions). If this is passed the candidate will be admitted in due course to the competitive examinations in the subjects—viz., Arithmetic, English Composition, with special reference to grammatical accuracy, Geography, and English History. Marks will also be given for spelling as shown in these exercises. The fee for the competitive examination is 1*s*. 6*d*.

These examinations are not held at stated and regular intervals, but as occasion may require, and are duly advertised. Intending candidates can procure through the booksellers specimens of examination papers.

TELEGRAPH LEARNERS, MALE AND FEMALE.

Competitive examinations for these situations are held, as a rule, twice a year, and are advertised like the other examinations in the newspapers. The candidates must apply to the Civil Service Commissioners, Cannon Row, Westminster, for permission to attend, and must be not less than fourteen nor more than eighteen years of age.

The subjects of examination are: Writing from dictation, Handwriting, Arithmetic (easy sums in first four rules). Examination fee 1*s*.

Successful candidates have to attend the post-office telegraph school to undergo a course of instruction in telegraphy, for which no charge is made. This course usually extends over a period of three months; but if after one month's trial—or at any time during this course, or during probationary employment—it becomes evident that a candidate does not possess any aptitude for the duties of a telegraphist, the nomination or probationary appointment is cancelled. No pay is given while the learner is receiving instruction at the school.

Male telegraphists on gaining their certificate from the school and commencing their period of probation receive 12*s*. per week; 14*s*. on obtaining a certificate of being fully competent for the transmission of public messages, and 16*s*. per week on being found competent to take sole charge of a telegraph instrument. After a year at 16*s*. per week, an advance is made to £45 per year, rising by £5 a year to £100. Promotions to higher classes depend on merit.

Female telegraphists commence with 10*s*. per week on receiving their certificate from the school and beginning the period of probation, rising to 12*s*. on being certified capable of transmitting public messages, and 14*s*. when found competent to take charge of a telegraph instrument; their salary is afterwards increased by 1*s*. per week to 17*s*., and then by 1*s*. 6*d*. per week to 27*s*. Female telegraph learners are liable to be called upon to do Sunday work.

It does not come within the scope of these articles to enter at any length into the details of situations requiring special and technical knowledge, or to deal with such inferior situations as those of messengers, porters, letter-carriers, sorters, etc., etc. Nor have we considered it necessary to include the particulars of examinations for the Civil Service of India held in June of every year, details of which may be obtained at the office of the Civil Service Commissioners in Cannon Row. There are, however, two or three openings for lads and young men which it may be well briefly to refer to. They are as follows: —

Apprentices to Shipwrights and Fitters in Her Majesty's Dockyards.

For these situations candidates must not be less than fourteen nor more than fifteen years of age on the first day of examination. Lists of candidates are kept at the Admiralty, and by the superintendents of the dockyards, to whom application must be sent in before March 1st in every year. Intending competitors may obtain all particulars as to examinations, pay, and prospect of promotion, etc., at the office of the Civil Service Commissioners, Cannon Row, Westminster.

Engineer Students in Her Majesty's Dockyards with a view to their being trained for service afloat as Engineer Officers in Her Majesty's Navy.

Candidates must be not less than fourteen nor more than sixteen years of age on the first day of the educational examination. A list of candidates for these appointments is kept at the Admiralty Office, London. Application for forms to be filled up by persons who wish to compete must be sent to the Secretary of the Admiralty on or after June 1st in each year, and must be returned filled up before the 1st March following. The educational examination will commence on the first Tuesday in May; and particulars as to qualifications, subjects of examination, pay, promotion, etc., can be obtained on application at the office of the Civil Service Commissioners, Cannon Row, Westminster.

Out-Door Offices of Customs.

These appointments are made by open competition; the age of competitors must be between nineteen and twenty-five on the first day of the month in which the examination is held, the subjects being Handwriting, Orthography, Arithmetic to Vulgar and Decimal Fractions, and English Composition. The salary of an out-door officer of Customs commences at £55 per annum, and rises by annual increments of £1 10*s*. to £80 per annum. The salary of the class above commences at £85 a year. Out-door officers are eligible for promotion to higher situations after a period of approved service, either by a further competitive examination or by selection on account of merit and good conduct.

Second-Class Assistants of Excise.

The age of candidates for these situations must be between nineteen and twenty-two on the first day of the month in which the examination is held. The subjects are: *obligatory*—Handwriting, Orthography, Arithmetic to Vulgar and Decimal Fractions, and English Composition; *optional*—Higher Arithmetic including Mensuration, Square and Cube Root, etc., Geography, especially that of the British Isles. Candidates must be unmarried, and without family. Salary, £60, with an allowance of 2*s*. per day when actively employed. Second-class assistants are eligible for promotion.

It is manifestly impossible within the limited space at our command, and it would be unnecessary, even if practicable, to enter here into all the details connected with employment in the Civil Service; but, probably, sufficient will have been said to give our readers a pretty clear notion of what is required of those who

wish to compete for Higher or Lower Division clerkships. It remains only to add first that, as the examinations are competitive, no one can afford to throw away a chance. It will be advisable, therefore, for intending candidates to gain some assistance from those who are accustomed to train young men for these examinations, and not trust to their own unaided efforts. This assistance may be obtained very inexpensively in the metropolis and some of the larger provincial towns, in connection with such institutions (in London) as the Birkbeck Literary and Scientific Institution, Southampton Buildings, Chancery Lane, or the City of London College, Leadenhall Street, where classes are conducted with especial reference to the Civil Service Examinations.

The second point to be noticed is that sterling character and industry, general good conduct, and a steady endeavour to discharge official duties, are not only essential to comfort and promotion, but even to continuance in the Civil Service when it has been entered. In one sense situations in the Service are permanent; but any servant may be discharged for misbehaviour and neglect.

VII.

Sewing Machinery.

When we think of the many millions of people that constitute the civilized world, and the vast number of stitches that must be made before the clothing of a single person can be considered complete, we are naturally surprised at the fact that until about fifty years ago sewing machines were practically unknown. Several machines had indeed been patented before then for embroidering, or special sorts of sewing, but these were all either so imperfect or limited in their capabilities that it would be incorrect to call them sewing machines as that expression is now commonly understood.

The first sewing machine that really deserves the name was patented in 1846 by Elias Howe, then a poor mechanic of Cambridge, Massachusetts. This, as is usual, was led up to by the previous inventions of others, and was itself capable of many improvements. In 1849, while Howe was struggling in London to do something with his invention, Mr. A. B. Wilson, now well known as of the firm of Wheeler and Wilson, but then a journeyman cabinet-maker in Pittsfield, Massachusetts, constructed a practicable sewing machine without any knowledge of what Howe had previously done. As might be expected, his machine differed in many points from Howe's; and, as will be seen below, the most important of these differences still remains in the modern machines of Wheeler and Wilson.

It is only natural that those who first attempted to sew by machinery should have endeavoured to exactly imitate the operation of hand-sewing. But these attempts were all doomed to fail, for an apparatus that shall push a needle through cloth and pull it out on the other side must needs be very complicated, and the trouble is increased by the fact that the length of thread to be pulled through decreases with every stitch that is made. The primary object of sewing, however, is to join together two pieces of fabric by means of cotton or thread; and so long as this end is attained the form of stitch matters but little, provided always that it is not unsightly, nor clumsily thick, and that an undue amount of thread is not required. In judging of machine sewing it is necessary to attend to these points, and also to observe whether the seam is secure, or whether a single break will be liable to loosen or undo the whole.

The simplest stitch is that known as "chain stitch," where the thread is disposed exactly as in the ordinary chain crochet. The thread is thrust through the fabric so forming a loop below, which is drawn through the previous loop, as will be evident from fig. 22. One of the loops is represented as not having been

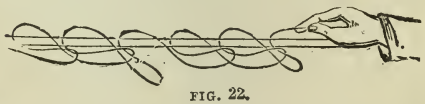


FIG. 22.

caught by the succeeding one—that is, a stitch has been missed, and the effect of this is shown in fig. 23; by merely pulling the loose thread all the previous sewing comes out. It is

FIG. 23.

obvious that for this stitch the thread used must be three times the length of the seam without allowing for the thickness of the fabric or the overlapping of the loops; practically each yard of seam requires about four-and-a-half yards of thread. This stitch is highly unsatisfactory on account of its unsightliness, its lack of security, and the large amount of thread that it requires.

Machines have been constructed for producing several other forms of stitches, but by far the most important is the ordinary lock-stitch produced by two threads, shown in fig. 24. About two-and-a-half yards of thread are required for each yard of seam, and if

FIG. 24.

a stitch is missed the security of the seam is not affected, for the result is merely a stitch of double length as shown in the figure. It will be most instructive to study the construction of sewing machines in general, by taking as

an example those that produce this form of stitch.

We may say that the action of such a machine consists of three operations—namely, the manipulation of the upper thread, and of the under thread, and the moving forward of the work so that the stitches formed may be of a definite and uniform length. These operations are distinct, but must work perfectly together; so that it is necessary for the motive power to be divided suitably by mechanical means. This is effected by turning, through the agency of a handle or treadle, a cogwheel, which communicates a revolving motion to two spindles by means of toothed wheels fixed upon them. One of these spindles gives the necessary motion to the needle which carries the upper thread, while the other works the bobbin with the lower thread, and moves the work forward.

The upper thread is used directly from the reel; but as the lower thread has to be passed bodily through loops made by the upper, it has to be wound upon a small reel or "spool," which fits into the "shuttle." This latter is merely a metal case that carries the lower thread, so that the spool may revolve within it, and is tapered towards one end, and carefully rounded and polished that it may be pushed through the loops formed below the work with certainty and ease. The upper thread is driven through the work by the needle which works vertically, and has its eye as close as possible to its point. In some machines, as the Singer, the needle is fixed to a needle-bar, which works up and down in bearings at the end of the fixed arm which carries the "presser-foot"; while in others, as the Wheeler and Wilson, it is attached to a lever working on a pivot. The former plan has much to recommend it; for the needle is straight, and therefore less liable to be broken than in the latter case, where the needle must be curved on account of the circular motion given to it. The Thomas machines, which are perhaps more suitable than most others for heavy work, belong to the former class.

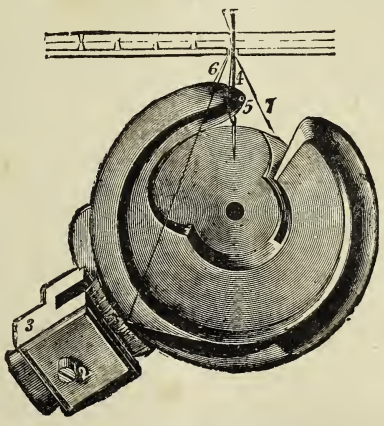


FIG. 25.

The simple shuttle, which by its to-and-fro motion carries the under thread through the loops formed by the upper, and then returns ready for the next stitch, is replaced in the Wheeler and Wilson machines by a very ingenious circular revolving hook, which catches the loop, and carries it round the spool containing the under thread. The spool in this case consists of two concave discs fixed on a short spindle with their edges in contact. It is placed loosely in a cavity prepared for it in the rotating hook, and so delivers the thread as required. The whole arrangement is shown in fig. 25 of its real size, where 7 is the under thread, 4 the needle, 5 the point of the hook just entering the loop formed by the upper thread, and 6 is the previous loop which has been carried over the spool, and is retained by the checkbrush 3 until the hook has caught the next loop, and by drawing it down can tighten the last one. The use of this rotating hook constituted one of the chief differences between the original machines invented by Wilson and Howe; and although it is admirable in its practical working as in its conception, it is found in the work-room that machines fitted with it will not bear so much rough usage as those which have the common shuttle.

It is necessary to give a certain amount of "tension" to both the threads, that the stitches may be drawn up close to the stuff; but at the same time the tension must be carefully regulated, or the thread will be broken or the work puckered; or if the tension of the two threads is not fairly equal, the tighter will draw the other through to the surface, and leave the loops visible, instead of making them within the thickness of stuff being sewn. The tension of the upper thread is regulated by passing it round a pin between two collars, which are pressed together by a spring adjusted by a screw-nut. The tension of the lower thread is made by passing it through a few holes in the side of the shuttle; or in the case of the rotating hook, by the pressure between the edges of the hollow discs of the thread-case.

The remaining essential part of the sewing machine is the apparatus by which the work is moved so as to give the stitches the necessary length. This is effected by what is called the four-motion feed, invented by Mr. A. B. Wilson in 1851. The work rests upon a "cloth plate," and is kept in position by the "presser-foot," which presses upon that portion of the work immediately surrounding the needle. Under the pressure-foot, and behind the needle, there is a rectangular hole in the cloth plate through which appears a small plate covered with coarse, blunt, saw-like teeth, the four-fold movements of which give the characteristic name to the invention. As soon as a stitch has been completed, this serrated plate rises and draws the work along, then while the stitch is being made it falls below the level of the cloth plate, and returns to its former position ready to repeat the action. The extent of the excursions of the plate is regulated by a screw.

There are many conveniences of minor importance attached to every well-appointed sewing machine. The thread is wound upon

the spool by slipping it between two centres so arranged that it is easily thrown into gear with the fly-wheel of the machine, and then revolves very rapidly when the wheel is turned at only a moderate pace. The turning down of hems, the marking of tucks, the guiding of the work, and other similar duties, are performed by simple contrivances that are fixed to the cloth-plate. The greatest improvements that have been made of late years in sewing machines are in those intended for heavy work, such as shoemaking, sewing leather belts, etc. But the "shoemaker's stitch" proper is altogether beyond the power of a machine, and the nearest approach to it is what is called the "Crispin stitch," introduced by Mr. John Keats, who has taken out thirty or forty patents relating to sewing machines. The most important innovation in these machines is the use of a needle shaped like a crochet hook, instead of having an eye like the ordinary sewing machine needle. Besides other advantages of a mechanical nature, this ensures the thread exactly filling the hole made for it—a point of considerable importance in making a boot, where a hole too large means the leakage of water inside. These machines are also so powerful that a sole one-and-a-half inch thick can be sewn through with ease.

It has been stated that certain machines are capable of making as many as four thousand stitches in a minute, but probably one thousand is more nearly the usual rate without allowing for the many stoppages that occur for the adjustment of the work, re-winding of the spool, etc. The results of experiments that have been carried out show that various sorts of work may be done by means of a machine in from a quarter to a fifteenth of the time necessary to do the same work by hand.

LI.

Some of the Irregular Verbs in most General Use, Alphabetically Arranged.

(In pronouncing these verbs, the accent should be placed on the syllable before the termination en of the infinitive and past participle. Thus emp=fehl=en, emp=fohl=en, ge=ſcheh=en, er=ſchall=en, er=ſcholl=en.)

In those verbs where there is an irregularity in the second or second and third person singular of the indicative present, it is marked. The first person of the present is always formed by taking away the final n from the infinitive.

These verbs should be carefully learned by heart. A complete list of the German irregular verbs is to be found in every dictionary.

Infinitive.	Imperf.	Past part.	Irregular 2nd and 3rd persons singular present.
Backen, to bake	ich buk, I baked	gebacken, baked	du bäckſt, er bäckt thou bakest he bakes

Befehlen, befahl, befohlen, du befiehlſt, er befiehlt, to command

Beginnen, begann, begonnen, to begin.

Beißen, biß, gebiſſen, to bite.

Bergen, barg, geborgen (du birgſt, er birgt), to conceal.

Berſten, barſt, geborſten, to burst.

Beſitzen, beſaß, beſeſſen, to possess.

Bewegen, bewog, bewogen, to move.

Binden, band, gebunden, to bind.

Bleiben, blieb, geblieben, to remain.

Brechen, brach, gebrochen (du brichſt, er bricht), to break.

Empfangen, empfing, empfangen (du empfängſt, er empfängt), to receive.

Empfehlen, empfahl, empfohlen (du empfiehlſt, er empfiehlt), to recommend.

Erſchrecken, erſchrack, erſchrocken (du erſchrickſt, er erſchrickt), to be frightened.

Eſſen, aß, gegeſſen (du iſſeſt, er ißt), to eat.

Fliegen, flog, geflogen, to fly.

Fliehen, floh, geflohen, to flee.

Fließen, floß, gefloſſen, to flow.

Frieren, fror, gefroren, to freeze.

Gebieten, gebot, geboten, to command.

Gedeihen, gedieh, gediehen, to prosper.

Geſchehen, geſchah, geſchehen (es geſchieht), to happen (impers.).

Gießen, goß, gegoſſen, to pour.

Gleichen, glich, geglichen, to be like.

Graben, grub, gegraben, to dig.

Greifen, griff, gegriffen, to grasp or seize.

Halten, hielt, gehalten (du hältſt, er hält), to hold.

Hauen, hieb, gehauen, to hew.

Heißen, hieß, geheißen, to be called (also, to command).

Helfen, half, geholfen (du hilfſt, er hilft), to help.

Klimmen, klomm, geklommen, to climb.

Kriechen, kroch, gekrochen, to creep.

Laden, lud, geladen, to load (also to summon).

Laufen, lief, gelaufen (du läufſt, er läuft), to run.

Lügen, log, gelogen, to lie (deceive).

Meſſen, maß, gemeßen (du miſſeſt, er mißt), to measure.

Nehmen, nahm, genommen (du nimmſt, er nimmt), to take.

Pflegen, pflog, gepflogen, to foster (also, to be accustomed).

Preiſen, pries, geprieſen, to praise.

Quellen, quoll, gequollen (du quillſt, er quillt), to spring forth, to *well* up.

Reiben, rieb, gerieben, to rub.

Riechen, roch, gerochen, to smell.

Ringen, rang, gerungen, to wrestle.

Schaffen, ſchuf, geſchaffen, to create (to work busily).

Scheiden, ſchied, geſchieden, to part.

Scheinen, ſchien, geſchienen, to seem, appear.

Schießen, ſchoß, geſchoſſen, to shoot.

Infinitive.	Imperf.	Past part.	Irregular 2nd and 3rd persons singular present.

Schleichen, schlich, geschlichen, to slink.
Schließen, schloß, geschlossen, to lock or shut.
Schneiden, schnitt, geschnitten, to cut.
Schreiben, schrieb, geschrieben, to write.
Schreiten, schritt, geschritten, to stride.
Schweigen, schwieg, geschwiegen, to be silent.
Schwinden, schwand, geschwunden, to decrease.
Schwören, schwor, geschworen, to swear.
Sieden, sott, gesotten, to boil.
Sprechen, sprach, gesprochen, to speak.
Sprießen, sproß, gesprossen, to sprout.
Stechen, stach, gestochen (du stichst, er sticht), to sting.
Stoßen, stieß, gestoßen, to push.
Tragen, trug, getragen (du trägst, er trägt), to carry.
Treiben, trieb, getrieben, to drive.
Treten, trat, getreten (du trittst, er tritt), to tread.
Verbieten, verbot, verboten, to forbid.
Verlieren, verlor, verloren, to lose.
Wachsen, wuchs, gewachsen, to grow.
Wägen, wog, gewogen, to weigh (active).
Weichen, wich, gewichen, to give way.
Wiegen, wog, gewogen (neuter), to weigh.
Winden, wand, gewunden, to wind.
Ziehen, zog, gezogen, to pull.
Zwingen, zwang, gezwungen, to compel.

Wie König Friedrich der Große von Preußen in Berlin ausfuhr und ausritt (*concluded*).

vee köh'-nich freed'-rich dare gross'-e fon proiss'-en in bare-leen' owss'-foor unt owss'-ritt

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Sonst[1] pflegte der König, wenn er bei Berlin Revue[2] hielt, zu reiten. Ein Augenzeuge beschreibt einen solchen Einritt[3] des Königs also: „Er kam auf einem großen weißen Pferde — dem alten Condé[4]— geritten. Hinter ihm waren eine Menge[5] Generale, dann die Adjutanten, endlich die Reitknechte. Das ganze

zonst pflaych'-te dare köh'-nich venn air by bairr-leen ray-vügh heelt tsoo ry'-ten ine ow'-gen-tsoy'-ge be-shrybt ine'-nen zol'-chen ine'-ritt dess köh'-nichs al'-zo airr kahm owff ine'-nem gross'-en vice'-sen pfairr'-de dame al'-ten kon'-day ge-rit'-ten hin'-ter eem vah'-ren ine nen'-ge ge-ne-rah'-le dann dee ad'-yoo-tant'-en end'-lich dee rite'-knech-te dass gan'-tse

Beforetime was accustomed the king, when he near Berlin review held, to ride. An eye-witness describes an such entry of the king thus: "He came on a great white horse — the old Condé— riding. Behind him were a crowd of generals, then the adjutants, at last the grooms. The whole

Rondeel[6] (jetzt Belle-Alliance-Platz) und die Rotunda (now Belle Alliance Place) and the

ron-dail' yetst bell'-al-li-ance'-plats unt dee

Wilhelmsstraße waren gedrückt voll Williams Street were crowded full

vil'-helms-strahs'-se vah'-ren ge-drückt' foll

Menschen, alle Fenster besetzt, alle of people, all windows occupied, all

men'-shen al'-le fen'-ster be-zetst' al'-le

Häupter entblößt,[7] überall das tiefste heads uncovered, everywhere the deepest

hoip'-ter ent-blöst' ue'-ber-all dass teef'-ste

Schweigen, und auf allen Gesichtern ein silence, and on all faces an

shvy'-gen unt owff al'-len ge-sich'-tern ine

Ausdruck[8] von Ehrfurcht und Vertrauen, expression of reverence and confidence,

owss'-druck fon airr'-foorcht unt fer-trow'-en

wie zu dem gerechten Lenker aller as to the just guide of all

vee tsoo dame ge-rech'-ten lenk'-er al'-ler

Schicksale. Der König ritt ganz fates. The king rode quite

shick'-sah-le dare köh'-nich ritt gants

allein vorn und grüßte, indem er alone in front and saluted in that he

al-line' forrn unt gruess'-te in-dame' airr

fortwährend[9] den Hut abnahm. Er continually the hat took off. He

fort-vairr'-end dane hoot ap-nahm' airr

beobachtete dabei eine gewisse Stufolge,[10] je nachdem die aus den maintained therein a certain gradation, according as the out of the

be-o-bach-te-te dah-by' i'-ne ge-vis'-se stoo'-fen-fol'-ge yea nach-dame' dee owss dane

Fenstern sich verneigenden Zuschauer[11] es windows bowing spectators it

fen'-stern zich fer-ny'-gen-den tsoo'-show-er ess

zu verdienen schienen. Bald lüftete[12] to deserve appeared. Soon lifted

tsoo fer-dee'-nen shee'-nen bald lüf'-te-te

er den Hut nur ein wenig, bald he the hat only a little, soon

airr dane hoot noor ine vay'-nich bald

nahm er ihn vom Haupte und hielt ihn took he it from (his) head and held it

nahm airr een fom howp'-te unt heelt een

eine Zeit lang neben demselben, bald a time long near the same, soon

i'-ne tsite lang nay'-ben dame-zel'-ben balt

senkte[13] er ihn bis zur Höhe des sank he it to the height of the

zenk'-te airr een bis tsoor hoch'-e dess

Ellbogens herab. Aber diese Bewegung dauerte fortwährend, und sowie elbow down. But these movements lasted continually, and so soon as

ell'-bo-gens her-ap' ah'-berr dee'-ze be-vay'-gung dow'-er-te fort-vairr'-end unt zo-vee'

er sich bedeckt hatte, sah er schon he himself covered had, saw he already

airr zich be-deckt' hat'-te zah airr shone

wieder andere bekannte[14] Leute und again other known (to him) people and

vee'-der an'-de-re be-kann'-te loy'-te unt

nahm den Hut wieder ab. Durch das
nahm dane hoot vee'-der ap doorch dass
took the hat again off. Through the

ehrfurchtsvolle Schweigen der Menge
airr'-foorcts-fol'-le shvy'-gen dare meng'-e
respectful silence of the throng

tönte nur der Hufschlag der Pferde
töhn'-te noor dare hoof-shlahch dare pfairr'-de
sounded only the hoof-bent of the horses

und das Geschrei der berlinischen
unt dass ge-shry' dare bair-lee'-nish-en
and the shouting of the Berlin

Gassenjungen[15] die vor ihm hertanzten,[16]
gas'-sen-yoong'-en dee fore eem har-e'-tants-ten
street-boys who before him danced on,

jauchzten, die Hüte in die Luft warfen,
yowchts'-ten dee hue'-te in dee looft varr'-fen
shouted, the hats into the air threw,

oder neben ihm hersprangen und
oh'-derr nay'-ben eem haré-sprang-en unt
or beside him onward sprang and

ihm den Staub von den Stiefeln abwischten.
eem dane stowp fon dane stee'-feln ap'-vish-ten
him the dust from the boots wiped off.

Man hörte ihn wol auch einmal,[17] wenn
man hoerr'-te een vole owch ine'-mal venn
One heard him well also once, when

der Lärm zu arg ward, mit auf-
dare lerrm tsoo arrg vahrt mit owf'-
the noise too bad became, with up-

gehobener Hand drohend sagen:
ge-ho'-be-ner hand dro'-end zah'-chen
lifted hand threateningly say:

„Wollt ihr wol, Jungens!"[18] Aber die
vollt eer vole yoong'-ens ah'-berr dee
"Will you well, boys!" But the

„Jungens" ließen sich nicht stören[19]
yoong'-ens leess'-en zich nicht stöh-ren
boys let themselves not be disturbed

und setzten ihre Spring- und Schrei-
unt zets'-ten ee'-re spring- unt shry'-
and continued their springing and shouting

übungen[20] fort, nach wie vor.
üh-bung-en fort nach vee fore
exercises on, after as before.

REMARKS ON THE FOREGOING STUDY.

[1] *Sonst* has various meanings. It signifies, in the first place, "otherwise": *Sie müssen dieses lesen, sonst werden Sie es nicht verstehen*, you must read this, otherwise you will not understand it. Applied to time, it is the opposite of *jetzt*, now: *Sonst war ich selber mit in Feld und Wald—jetzt kann ich nichts mehr als den Schaffner machen*, formerly was I myself in field and forest—now I can be nothing but the steward (Schiller); *Sonst und jetzt*, beforetime and now.

[2] *Revue*, a military term adopted from the French. The German word is *die Heerschau*, from *das Heer*, the army; and *schauen*, to see or inspect. We have the same construction in the old words "Wapentake" and "Wapenshaw" (*Waffen-schaw*).

[3] *Der Einritt*, literally the riding in. Thus we have also *der Ein-marsch*, the marching in; *der Einzug*, the coming in (entering in procession); *der Eintritt*, the entrance (stepping in), etc.

[4] Frederick was accustomed to name his horses after celebrated generals. Old Condé was a prime favourite with him, and was as well known in Berlin as the great king himself.

[5] The German verb *mengen* (*mengte, gemengt*) signifies to mingle or mix. Thus the word *die Menge* is often used for the crowd: *Das die Menge gaffend umstehet*, that the crowd, gaping, surrounds (Schiller's *Die Bürgschaft*); "The mutable rank-scented many" (Shakespeare's *Coriolanus*).

[6] *Das Rondeel*, the round place. The name was changed after the war of liberation against Napoleon.

[7] *Entblösze* (*entblößte, entblößt*), to uncover, to lay bare; from *blosz*, bare, naked.

[8] *Der Ausdruck*—the expression is quite literal: from *druck*, pressure, and *aus*, out.

[9] *Währen*, to last, to endure; thus *fortwährend*. The term *immer-während*, ever-enduring, is also used.

[10] *Die Stufenfolge*, the gradation; from *folgen*, to follow, and *die Stufe*, the step (step-following).

[11] *Die sich aus den Fenstern verneigenden Zuschauer*. This is an idiomatic construction in German; it consists in leaving out the relative pronoun *welcher, welche, welches*, and turning the verb into a participial adjective (*die Zuschauer* WELCHE *sich aus den Fenstern* VERNEIGTEN). It renders the style more concise.

[12] *Lüften* is a special term not often used. *Heben* is the general term for "to lift."

[13] There are two verbs for the English "to sink": *senken, senkte, gesenkt* is active and transitive, to sink anybody or anything, a shaft, etc.—*Er senkte den Leichnam in den Strom*, he sank (lowered) the corpse into the stream; *sinken, sank, gesunken* is the neuter verb: *Er sank auf den Stuhl*, he sank into the chair.

[14] *Bekannt*, from the verb *kennen*, to know (the French *connaitre*); thus *Ein alter Bekannter*, an old acquaintance. The word *die Bekanntschaft* is also used.

[15] *Die Strasse* (the Roman *Strata viarum*) was generally used for the larger streets or main thoroughfares; *die Gasse*, the old German word, is generally employed for the lanes or narrow tortuous streets. In modern times it has become obsolete, all new streets, large and small, being designated as *straszen*. An instance of the old application was seen in the now disestablished *Judengasse*, the picturesque old Jews' Street at Frankfort-on-the-Maine.

[16] *Hertanzten, hersprangen*. The prefix *her*, in this place, signifies "onward" came, dancing on, jumping on—*her*, hither—consequently towards the spectator.

[17] *Einmal* is not here literally *once*, but "once and again," "now and then."

[18] "*Jungens*" is in inverted commas, because it is a familiar expression; the real plural of *der Junge* is *die Jungen*. "*Wollt ihr in die Schule gehen, ihr Jungens!*" "Will you go to school, you boys?" was old Fritz's general good-humoured remonstrance, when the boys' antics became irrepressible.

[19] *Stören*, to disturb, to *stir* any one from his repose.

[20] *Üben* (*ubte, geübt*), literally to practise. *Auf dem Klavier üben*, to practise the piano.

XLVII.

ROME (*continued*).

THE first serious trouble that had to be dealt with, following the events spoken of in our last article, was a revolt in Spain, led by Sertorius, formerly an officer in the army of Marius. On the defeat of the Marian party he had withdrawn into Spain, where he soon found himself the chosen leader of a great revolt against the Roman power. He defeated the generals of the senate, and at last Pompeius was sent against him. Pompeius, though only about thirty years of age, was already considered the greatest of the generals of the time. Even he had but small success against the rebel leader. But at last Sertorius, after defying the senate for eight years, having lost his popularity with his followers, was murdered by his own officers; his

Revolt in Spain.

party was soon after completely conquered by Pompeius, and Spain submitted again to the senate. Meanwhile affairs were going badly in Italy. Food was scarce, and as a consequence agitation and disorder prevailed in Rome. Besides this, the pirates who infested the Mediterranean made constant raids on Italian seaports, and sacked even the temples; while Mithridates was threatening another invasion of the eastern provinces. Worse than all

Rising of the Gladiators.

was the rising of the gladiators in southern Italy. These gladiators were slaves, captives of war and criminals, regularly trained in schools to fight in the shows for the people's amusement. A band of them escaped and established themselves in the crater of Mount Vesuvius, under a leader named Spartacus, who proved to be both a great general and a wise leader. His band was quickly joined by other gladiators and peasants, to the number at one time of 100,000. Spartacus wished to lead his men over the Alps to the other side, where most of them had come from; but the hope of plunder was too strong for them, and they refused to follow. For three years they maintained themselves in the south of Italy, defeating the armies of the senate. Pompeius was recalled from Spain to cope with them, and he and Crassus succeeded in killing Spartacus and dispersing his army.

Pompeius and Crassus consuls.

The popularity of Pompeius was now greater than ever, and though still below the legal age he was elected to the consulship with Crassus as his colleague. Crassus had amassed immense wealth, and by his unscrupulous ability had become one of the most influential men in Rome. But a greater man than either Pompeius or Crassus was already pressing to the front. This was Julius Cæsar. He was of noble family, descended according to tradition from Æneas, the Trojan hero. Marius had married his aunt, and Cæsar while a mere youth had joined his uncle's faction and narrowly escaped death in the proscriptions of Sulla because he refused to put away his wife, the daughter of Cinna. His connection with the Marian party, as well as his captivating personal qualities, made him a great favourite with the people. At the time we have now reached he had formed in his own mind the intention to overthrow the republican form of government, which in fact had long been a mere fiction, and to establish himself permanently as sole ruler. The history of the last twenty years had probably convinced him that the republican form of government must soon give place to government by a single ruler, and Julius Cæsar determined that none but himself should be that ruler. But to carry out his scheme an army devoted to him was necessary, and his efforts were all directed to that end. How he succeeded we shall see presently.

Julius Cæsar.

JULIUS CÆSAR.

In the game which was now to be played at Rome for supreme power, the principal players were Pompeius and Cæsar. But there were minor players, some of whom were great men too. Of these Cicero, the great orator and writer, was the most eminent. He had neither birth nor wealth to aid him, but he rose by his industry and brilliant oratory to be consul and to exercise great influence for a time. He was in favour of moderate reform. Cato, the great-grandson of Cato the censor, was

Cicero.

Cato.

the most upright and high-principled of the nobles. He was the highest of the high tories of the day. He believed that the nobles were the natural and only safe rulers of the Romans, and that the Romans were the natural rulers of the world. He imitated the austere simplicity of the ancient patricians, and had strongly condemned the excesses of his own party under Sulla. But his influence outside his own order was small, and he utterly failed to see the drift of the events of the time. Crassus we have already spoken of. He appears to have been quite willing to adopt any policy that would advance his personal interest.

Exploits of Pompeius.

In the year 67 Pompeius got himself appointed, with unusual powers, to the command of an expedition against the pirates who swarmed in the Mediterranean. The enterprise was splendidly successful in a few months. Next year he was sent against Mithridates, who had been giving great trouble again. This expedition was equally successful. Mithridates was defeated at last, and to save himself from capture killed himself. Then Pompeius subdued Syria and Judæa, taking Jerusalem after some resistance; and having added four new provinces to the Roman empire, returned in triumph once more to Rome.

Catalina's conspiracy.

In his absence had been formed and defeated the conspiracy of Catalina, made memorable by the speeches of Cicero, which fortunately have been preserved to us. Catalina was a dissolute young noble, weighed down with debt, and sunk in the most desperate vices, but possessed of great abilities. He gathered round him a band of desperadoes in the same plight and of equally vicious lives. In the hope of bettering their ruined affairs and shaking off their debts, they planned a revolution. Their plan was to gain over the good will of the army nearest to the city, and at a given signal, when things were ripe, to set fire to the city in a number of places and to massacre the consuls and the partisans of the existing government; then in the confusion, and while the state had no recognized head, to seize supreme power and maintain it with the aid of their army. Cicero, the consul, was informed by spies of all the conspirators' movements; but so difficult was it at that time to get justice executed against criminals, and so apathetic were the Romans generally, that Cicero did not dare to arrest Catalina. His plan was to frighten Catalina out of the city and compel him to show his hand openly by some overt act against the state. In this Cicero succeeded. Catalina fled, for fear of arrest, and having raised an army, gave battle to the consul's army, and was slain, B.C. 62. Meanwhile Cicero had seized his adherents in the city and put them to death without trial. This was probably quite necessary for the safety of the state in such a critical moment. But it was hardly legal, and Cicero's enemies took advantage of it afterwards to get him banished.

Defeated by Cicero.

When Pompeius returned in 62, after his campaign in the east, he was soon drawn into Cæsar's schemes for practically setting aside the senate. They two, along with Crassus, agreed to help each other to get all they wanted at the expense of the senate; and there is little doubt that Cæsar foresaw that it would be possible to oust his rivals in time and thus get all the power into his own hands. Accordingly, in B.C. 59, Cæsar was made consul, and in return he got a law passed for granting lands to the veterans of Pompeius' army. Then the people were induced to give Cæsar the governorship of Gaul for five years, and to supply him with a large army for the purpose of fighting the Gauls.

Designs of Cæsar.

Here was Cæsar's opportunity. An army devoted to him was the one thing necessary for his scheme, and he determined never to give up the command of that army till he had attained his object. But to carry out this determination required the highest faculties of a statesman and a soldier. He was not strong enough yet to be independent of the people, and he could only hope to have a majority of them on his side by keeping on good terms with his rivals Pompeius and Crassus. Cæsar went to Gaul in 58 B.C. For the next two years he devoted himself with all his energies to subduing the Gauls, at the same time enlarging his army by recruits from the conquered people and training it to the highest point of discipline. His military successes and his great personal influence insured the devotion of his army, and his mild and just rule over the conquered tribes quite reconciled them to the Roman yoke; and though he left the country in a few years and took his army with him, yet the natives never tried to recover their freedom. The whole of what we know as France and Belgium submitted to him, and in B.C. 54 he even crossed to Britain, but had not time to plant a settlement there. Not only was he a great general all these years: he was also a great writer, and kept a careful record of what he saw and did in these strange countries. It is from his "Commentaries," as he called this record, that we have the earliest trustworthy accounts of our own British ancestors, as well as of many other things and people of western Europe.

Cæsar in Gaul.

Cæsar in Britain.

Cæsar's governorship of Gaul was only given to him for five years, and he soon saw that that would not be long enough, so he agreed again with Pompeius and Crassus that he would help them to the consulship if they got him appointed to Gaul for another five years, so that his command there would not come to an end until the year 48 B.C. This arrangement was carried out. Then Crassus was given the province of Syria for five years, and Spain was given to Pompeius for the same period. Crassus set off at once to his province, and soon after was slain in battle by the Parthians. There was now no one to hold the balance between Cæsar and Pompeius. The latter remained at Rome instead of going to Spain, and managed to get his appointment prolonged for another five years. The effect of this on

Rivalry of Pompeius and Cæsar.

Cæsar's plans was highly important, because, when the time should come for him to give up his command in Gaul and return to Rome without an army, Pompeius would still have command of a large army in Spain; and so marked had the rivalry between these leaders now become that every one felt that Pompeius would, in such circumstances, make use of his army to compel Cæsar to quit Rome and destroy his influence there, while Pompeius and his friends got all the power into their own hands. Cæsar and his party at Rome determined not to acquiesce in this arrangement. They proposed that Cæsar and Pompeius should both give up their provinces at the same time, or else that Cæsar should be allowed to stand for the consulship during his absence in Gaul, so that he might return to Rome not as a private individual but as consul. The senate, who were more favourable to Pompeius than to Cæsar, refused this proposal, and even threatened to deprive of their offices some of the tribunes who took Cæsar's side. Thereupon these tribunes fled from Rome to Cæsar and called upon him to sustain them against the illegal conduct of the senate. He determined to avail himself of so good an excuse for attacking the senate and through them ruining their friend Pompeius. The province of Gaul was divided from the north of Italy by the little, but ever after famous, river called the Rubicon. Beyond this stream it was not lawful for Cæsar to come with his army, and to do so was equivalent to an act of civil war. But Cæsar had now decided that the moment for action was come. On the 15th of January B C. 49 he crossed with a small army. The senate and Pompeius, who had assumed the command at Rome, seem to have been unprepared for such bold and rapid action. The people, who were on the whole strongly in favour of Cæsar, did not rally to Pompeius. He weakly determined to quit Rome, and the senate and many of the citizens went with him, thinking it unsafe to remain and trust to Cæsar. The latter marched after him as fast as he could, hoping to inflict a defeat upon him and perhaps crush him with one blow. But Pompeius got to Brundisium (the modern Brindisi) just in time to embark with the senate for Greece, leaving Cæsar undisputed master of Italy. This exploit of Cæsar's took just two months from the day he crossed the Rubicon, and was effected without bloodshed, towns and garrisons joining or submitting to him without a blow, so thoroughly had he secured the good will of all the people. But the armies of Pompeius in Spain were still faithful to their leader, and Cæsar had to march against them. His success was rapid and complete, and he then returned to Rome for a few months to consolidate his authority there. He now determined to follow Pompeius himself, who had collected a large army in Greece. It was the deliberate intention of Pompeius to "conquer" Rome by the aid of the "barbarians" from all parts of the world that he hoped to attract to his standard, and then to "reign like Sulla as a king over his subjects," no doubt imitating him also in the proscriptions of his enemies. The prospect was not a cheerful one for the Romans, and it made numbers of them turn to Cæsar as the best chance of averting such a calamity. Pompeius' great reputation in the east was sufficient to attract a great host of minor kings and princes with their armies.

Cæsar crosses the Rubicon.

Pompeius quits Rome,

and flies to Greece.

XVII.

South America (*continued*).

Peru extends along the coast of the Pacific from Ecuador on the north to Chili on the south, and has on the east Brazil and Bolivia. The coast line measures about 1600 miles, and the area is computed at 432,500 square miles. The Andes traverse the country parallel with the coast, and at a distance of about sixty miles therefrom, the intervening space being sandy desert, except where watered by transverse mountain streams. Beyond the mountains the country is fertile and well wooded, being in the basin of the Amazon, and traversed by numerous fine rivers. Peru is particularly noted for its mineral wealth, especially silver; gold, iron copper, tin, mercury are also found. The Chincha, Lobos, and other islands off the coast, have immense stores of guano. The government is republican, with a President and Council. Population, 3,050,000, of whom 350,000 are Indians. The capital, Lima, has 101,488 inhabitants.

Bolivia is bounded north and east by Brazil, south by the Argentine Republic, and west by Chili and Peru. It formerly possessed a small portion of coast toward the Pacific, but this has been appropriated by Chili through the late war. The area is 500,000 square miles, and the population 2,325,000. The northern and eastern portions belong to the basins of the Amazon and Paraguay. The chief products are maize, oats, barley, rice, cotton, cocoa, indigo, cinchona bark, medicinal herbs, fruits. The mineral wealth is great, including gold, silver, lead, copper, tin. The silver mines of Potosi have long been famous. The government is republican, with a President and a Congress of two chambers.

Chili comprises a long, narrow strip of territory lying between the Andes and the Pacific, and extending from Peru southward to the extremity of the continent at Cape Horn. It is about 2200 miles in length, while its average breadth is under 100 miles, and its area (without reckoning the portion of Patagonia included in it) is 125,000 square miles. Population, 2,155,029. The chain of the Andes which runs along its eastern frontier, has an average elevation of 12,000 or 13,000 feet, while some of its peaks rise to 22,000. In the north, where little or no

rain falls, the territory is sandy and barren ; but farther south, where well watered, the country is very fertile, producing abundant crops of maize, wheat, barley and other grains, and fruits of various kinds. Large herds of cattle and horses are reared. The country is very rich in minerals, especially gold, silver, copper, lead, iron, coal, and precious stones. This is considered the most advanced and prosperous of the American republics. It has a President, a Senate of 37, and a Chamber of Deputies of 109 members. Capital, Santiago.

THE ARGENTINE REPUBLIC is bounded north by Bolivia, west by Chili, south by Patagonia, and east by the Atlantic, Uruguay, Brazil, and Paraguay. Area, 827,200 square miles. Population, about 2,400,000. It likewise claims all Patagonia lying east of the Andes, with an area of 350,000 square miles, and about 30,000 inhabitants. The greater part of the surface consists of vast plains or pampas covered with coarse grass. on which immense herds of horses, cattle, and flocks of sheep are fed, constituting the chief wealth of the people. Agriculture is little attended to. The spurs of the Andes in the west are rich in metals, as gold, silver, copper, tin, lead, and iron. The chief exports are wool, hides, salted beef, bones, horns, tallow, and the metals. The republic is governed by a President, a Senate of 28, and a Chamber of Deputies of 86 members. Capital, Buenos Ayres.

PARAGUAY is bounded north and east by Brazil, and south and west by the Argentine Republic. It has on the east, west, and south the rivers Parana and Paraguay, and the soil is watered by numerous streams, and very fertile. The inhabitants are chiefly engaged in agriculture. The chief products are maize, rice, coffee, cocoa, Paraguay tea, sugar, cotton, tobacco, and indigo. Area, 92,000 square miles. Population, 293,844, greatly reduced by the six years' disastrous war with Brazil and the Argentine Republic (1865-70). It is governed by a President, a Senate, and a Chamber of Deputies.

URUGUAY is bounded north by Brazil. east by the Atlantic, south by the Rio de la Plata, and west by the Argentine Republic. Area, 70,100 square miles. Population, 450,000. The principal river is the Uruguay, which forms its western boundary. In the south and west are extensive grassy plains, while the northern and eastern parts are mountainous or undulating. Wheat, barley, and maize are cultivated, but the inhabitants are chiefly engaged in rearing horses, cattle, and sheep, of which there are immense numbers. The chief exports are wool, hide, tallow, jerked beef, and tinned meats. It is governed by a President, a Senate, and a Chamber of Deputies. Capital, Monte Video.

AUSTRALASIA.

AUSTRALASIA, literally signifying southern Asia, is the name commonly given to the sixth great division of the globe, lying south-east of the continent of Asia, between the Indian and Pacific Oceans. It consists of Australia, New Zealand, Tasmania, Papua or New Guinea, and numerous smaller islands lying between the equator and lat. 55°S. and long 113° and 180°E.

AUSTRALIA, the main portion of Australasia and the largest island in the world, lies between lat. 10° 40′ and 39° 10′ S. and long. 113° and 153° 35′ E. Its length from west to east is 2500 miles, and its greatest breadth 1950 miles. Area 2,983,386 square miles, or about three-fourths of that of Europe. Population 2,850,000. It is separated from New Guinea on the north by Torres Strait, eighty miles broad, and from Tasmania on the south by Bass Strait, 140 miles wide ; while New Zealand lies 1200 miles distant from its south-east coast. The coast of Australia presents few irregularities, the principal gulfs being those of Carpentaria on the north and Spencer on the south. Except along the east and west coasts the surface of the country is generally low, giving rise to the hypothesis that at no very remote period it formed part of the bed of the ocean. Along the entire line of the east coast, from Portland to Cape North, occur a succession of mountain ranges, called in different parts the Australian Grampians, Australian Pyrenees, Australian Alps, Blue Mountains, Liverpool Range, etc. These constitute, like the Andes of South America, a regular cordillera, stretching from south to north, 1700 miles in length, with an average height of 1500 feet, while the highest

LYRE BIRD. CRESTED PIGEON. BRUSH TURKEYS.

point in the country, Mount Kosciusko, in the Alps, is 7170 feet above the sea. On the western side a range of mountains extends similarly from south to north. The interior consists chiefly of vast sandy and stony plains, very deficient in vegetation, and containing numerous salt marshes. The eastern portion of the island, and nearly all round the coast, is a rich grazing country, admirably adapted for the rearing of sheep, which is the principal occupation of the people.

The largest river of Australia is the Murray, which rises in the Australian Alps, flows westward, forms the boundary between New South Wales and Victoria, and after a course of 1100 miles, falls into the Southern Ocean. Its chief affluents are the Murrumbidgee, with its tributary the Lachlan, and the Darling with its tributary the Macquarie. The northern half of the island lies within the torrid zone, the southern within the south temperate zone; consequently the climate varies greatly in different parts. Generally in the settled districts it is very pleasant and salubrious, resembling that of southern Europe. The vegetable and animal kingdoms differ considerably from those of other countries. The trees and shrubs are almost all evergreens. Of the former the eucalypti or gum trees are the most characteristic. There are few indigenous fruits capable of being used as food, but most of those common in Europe have been introduced, as grapes, figs, oranges, peaches, etc. Almost all the mammalian animals here are marsupial. Among the more remarkable are the kangaroo and the ornithorhynchus, a four-footed animal which has the bill and feet of a duck with the body and fur of a mole. Many of the birds are distinguished for the grace of their form and the beauty of their plumage. Australia is rich in the precious metals, especially gold. Silver, copper, lead, tin, iron, and coal are also found. The aborigines rank among the lowest of the human race, being inferior, both in moral and intellectual qualities, to the African negro. They are ignorant of agriculture, have no flocks or herds, no houses or fixed abodes, but are constant wanderers. Their numbers now probably do not exceed 200,000.

NORTH AUSTRALIAN. SOUTH-EAST AUSTRALIAN. TASMANIAN.

LATIN.

LI.

THE IMPERATIVE MOOD.—THE ROMAN CALENDAR.—WEIGHTS AND MONEY.

A. The Imperative Mood.

(1) The Present Imperative is used in ordering, directing, advising, exhorting, with respect to the *immediate* present or without reference to any definite time, and also in salutations—as in *Carpe diem*, seize or enjoy the day (that now is); *Salve*, *Ave*, Hail to thee; *Vale*, Farewell.

(Observe that *not* in prohibitions is expressed by *ne*, never by *non*, and in double sentences by *neu* or *neve* (= *ne vel*) *neve*—*neve*—as in *Ne tu crucias obsecro*, do not torment thyself, I pray thee.)

(2) The Future Imperative is used in commands and exhortations in reference to the future as well as to the present, and hence it is always used in *laws* and in *emphatic* commands—as in *Hominem mortuum in urbe ne sepelito, neve urito*, thou shalt not bury, nor shalt thou burn, a dead man in the city; *Hanc tu, Romane, caveto*, O Roman, remember to be on your guard against this man.

(3) The Subjunctive Present is sometimes used (*not in laws* or for the sake of emphasis) instead of the Imperative, especially in the third person—as *Aut bibat aut abeat*, let him either drink or go away.

Observe that the *second* person of the subjunctive mood is properly used only in a general proposition, when it may be translated by the English *one*—as *Majores natu in honore colas*, one should respect one's elders.

(4) A prohibition may be expressed by *ne* (and *nemo* and *nihil*) with the *Subjunctive*, generally with the third person of the present and the second person of the perfect tense—*Ne transieris rivum*, do not cross the river.

(Observe that an *emphatic* prohibition is sometimes expressed by *noli*, *nolite*, *nolitote*, with the infinitive; as much as to say, not only do not, but *do not ever think* of doing it—as in

Noli hunc hominem occidere, do not even think of putting this man to death.)

B. The Roman Calendar.

The Roman Calendar agreed with our English Calendar in the number of months and of the days in each; but the Roman manner of dating was very different.

Each month had three distinguishing days, namely:—

The Kalends (*Kalendæ*, gen. *-arum*), which fell on the 1st.

The Nones (*Nonæ*, gen. *-arum*), which fell on the 5th, *usually*.

The Ides (*Idūs*, gen. *-uum*), which fell on the 13th, *usually*. But in March, May, July, and October, the Nones fell on the 7th and the Ides on the 15th.

Observe in dating:—

(*a*) The 1st, 5th, and 13th were denoted by the ablatives *Kalendis*, *Nonis*, *Idibus*, with the name of the month added in agreement—as *Kalendis Ianuariis*, the 1st of January. But in March, May, July, and October, *Nonis* and *Idibus* stood for 7th and 15th respectively.

(*b*) The day before the Kalends, Nones, or Ides, was denoted by the adverb *pridie*, the day before, used like a preposition governing an accusative case—as *pridie Kalendas Ianuarias*, the 31st of December; *pridie Idus Ianuarias*, the 12th of January; *pridie Idus Martias*, the 14th of March.

(*c*) All other days were denoted by reckoning *back* from the next ensuing Kalends, Nones, or Ides. The reckoning included not only the day reckoned *from* but the day reckoned *to*: thus the 30th of December was called the *third* not the *second* day before the Kalends of January. The form for expressing the date thus found is as follows:—

Ante diem tertium Kalendas Januarias, the 30th of December.
Ante diem octavum Idus Januarias, the 6th of January.
Ante diem quartum Nonas Martias, the 4th of March.
Ante diem duodevicesimum Kalendas Maias, the 14th of April.

A short form for expressing the above dates is as follows:—

a. d. III. Kal. Jan., the 30th of December.
a. d. VIII. Id. Jan., the 6th of January.
a. d. IV. Non. Mart., the 4th of March.
a. d. XVIII. Kal. Mai., the 14th of April.

Note 1.—An easy method of finding the Roman date corresponding to an English is by adding 1 to the Nones or Ides, or 2 to the days of the month, and then subtracting the English date from the result. Thus, to find the Roman date for the 6th of January: $13 + 1 = 14$, and $14 - 6 = 8$. Hence our 6th of January is the Roman 8th day before the Ides. So the 4th of March is $7 + 1 - 4 = 4$; the 14th of April is $30 + 2 - 14 = 18$, etc.

Note 2.—In leap-year the 24th of February (*ante diem sextum Kalendas Martias*, or *a. d. VI. Kal. Mart.*) was reckoned for two consecutive days. Hence this day was called *dies bissextus*, and leap-year itself *annus bissextus*. In such years the additional day was not reckoned in calculating the date from the 14th to the 24th of February. Thus *a. d. X. Kal. Mart.* stood for the 20th of February, whether the year was leap year or not.

Note 3.—The phrase for expressing a date was considered as a single word admitting of government by the prepositions *in* and *ex*—as *Supplicationes edictæ sunt in antediem quartum et tertium et pridie Kalendas Novembres*, public thanksgivings were decreed for the 29th, 30th, and 31st of October; *Supplicatio indicta est ex antediem quintum Idus Octobres*, a public thanksgiving was decreed, beginning from the 11th of October.

Note 4.—The names of the months were *Januarius*, *Februarius*, *Martius*, *Aprilis*, *Maius*, *Junius*, *Julius*, *Augustus*, *September*, *October*, *November*, *December*. These are adjectives, but may be used as substantives, *mensis* being understood.

Note 5.—The months of July and August were called *Quintilis* and *Sextilis* before the time of the Emperor Augustus.

Note 6.—Remember that in March, July, October, May, the Nones fall on the seventh day, while in the other months they fall on the fifth day.

C. Roman Weights and Money.

(1) The *as*, or *pound*, also called *libra*, which served as the standard unit both for weights and coins, was divided into twelve parts.

Assis Romani partes sunt UNCIA, SEXTANS, QUADRANS, *atque* TRIENS, QUINCUNX, *et* SEMIS, *et inde*
SEPTUNX, BES, DODRANS; DEXTANTI *junge* DEUNCEM.

Uncia	$= \frac{1}{12}$	of an *as*	= 1	ounce.
Sextans	$= \frac{2}{12} = \frac{1}{6}$	of an *as*	= 2	ounces.
Quadrans	$= \frac{3}{12} = \frac{1}{4}$	,,	= 3	,,
Triens	$= \frac{4}{12} = \frac{1}{3}$	,,	= 4	,,
Quincunx	$= \frac{5}{12}$	,,	= 5	,,
Semis	$= \frac{6}{12} = \frac{1}{2}$	,,	= 6	,,
Septunx	$= \frac{7}{12}$ =	,,	= 7	,,
Bes	$= \frac{8}{12} = \frac{2}{3}$	,,	= 8	,,
Dodrans	$= \frac{9}{12} = \frac{3}{4}$	,,	= 9	,,
Dextans	$= \frac{10}{12} = \frac{5}{6}$	,,	= 10	,,
Deunx	$= \frac{11}{12}$	,,	= 11	,,

(2) *Terms used in bequeathing property.*—*Heres ex asse*, heir to the whole estate; *heres ex deunce, dextante*, etc., heir to eleven-twelfths, five-sixths, etc.

Interest.—In the later times of the republic the Romans reckoned interest by the month, not by the year. Hence, *asses usuræ* = 1 *as* per cent. per mensem = 12 per cent. per annum; *deunces usuræ* = $\frac{11}{12}$ of an *as* per cent. per mensem = 11 per cent. per annum, and so on. Instead of *asses usuræ* we sometimes find the phrase *centesimæ usuræ*, or simply *centesimæ*—*i.e.* hundredth parts of the principal paid monthly, or 12 per cent. per annum. *Binæ centesimæ* = 24 per cent.

(3) The *sestertius*, or *nummus sestertius*, was a coin of the value of $2\frac{1}{2}$ *asses*, being rather more than twopence of our money before the reign of Augustus, and rather less than that sum afterwards. It is denoted by the symbol

HS. (*i.e. L(ibra) L(ibra) S(emis)*, or perhaps *IIS(emis)*, 2½ pounds.)

The sum of 1000 *sestertii* was called *sestertium*, roughly equivalent to about £8 English money. This also was denoted by the symbol *HS.*

The expression for a million *sestertii* was *decies centena millia sestertiûm* (for *-orum*); for 1,100,000 *sestertii, undecies centena millia sestertiûm*, etc. The words *centena millia* are often understood; hence, *decies sestertium*, a million; *millies HS.*, a hundred millions, etc.

Notice also that *HS.* may be distinguished in its sense of *sestertiA* from *HS.* in the sense of *sestertii*—a line is drawn over the numeral subjoined. Thus *H.S.M.D.* = 1500 *sestertii;* but *H.S.M.D.* (*mille decem*) = 1500 *sestertia* —*i.e.* 1,500,000 *sestertii.* To make *centena millia sestertiûm* a line is sometimes placed over the whole expression—as *H.S.M.D.* = *millies et quingenties centena millia sestertiûm* = 150,000,000 *sestertii* or 150,000 *sestertia.*

Self-Examination Questions and Exercises.

What conditions are marked by the use of the present imperative? What are the negative particles used in double sentences which are prohibitive? Give examples. How do you translate into Latin the English *one* as the subject of a verb? What are the two emphatic forms of the imperative, positive and negative? Give examples. Give a brief account of the Roman methods of reckoning time and money and weight. What do you mean by the following terms—*Kalends, Nones, Ides, Heres ex asse, Annus bissextus?* Give the names of the twelve months in Latin, and state what parts of speech they were originally. How do you distinguish *sestertium* from *sestertius?* How was interest reckoned by the Romans? Account for the symbols *HS.*, *H.S.M.D.*, *H.S.M.D.*, and *H.S.M.D.* What were the original names of the months called *Julius* and *Augustus*?

Translate into English :—

Hoc gerere memento ante diem octavum Idus Januarias. Ne occidito servum die bissexto neve anno bissexto. Hæc magna supplicatio edicta fuit in ante diem quartum et tertium et pridie Kalendas Novembres. Imperator Romanus erat ejus hæres ex asse. Nonis Decembribus mortuus est, atque Caium reliquit fundi heredem ex sextante, quod fuit decies sestertium. Ne quis ex urbe exeat ante diem decimum quartum Kalendas Maias. In ante diem octavum et septimum Kalendas Octobres comitiis a consulibus dicta dies. Supplicatio omnium Romanorum civium erit ante diem quintum Idus Octobres. Fēnus (*interest*) Romæ et Athenis diu erat ex triente bessibus. Accepi vicies ducenta triginta quinque millia quadringentos decem et septem nummos. Argenti ad summam sestertia decies in ærarium rettulit. Regio imperio duo magistratus sunto. Non satis est pulcra esse poemata, dulcia sunto. Injurias fortunæ, quas ferre nequeas, defugiendo relinquas. Emas non quod opus est, sed quod necesse est. Nihil ignoveris.

Translate into Latin :—

Let no man kill a citizen without a just cause. One should always defend one's country against its enemies. Now do not cross the river, flowing violently as it does. Let them come at once [emphatic], being ordered by me. Did the consul die on the 1st of December? What great battle was fought by the Romans on the 13th of November? A public thanksgiving has been appointed, to begin from the 5th day of December. He was very rich, and had one million sisterces. He left his brother heir to three-fourths of his estate, His sister will receive seven-twelfths of the property of her father. Do not think of punishing the boy very severely. Does not death admonish all men of religion? What soldiers were in the camp on the 27th of December? How many brave men have perished in what one may call a most bloody, disgraceful, and careless war! Condemn not the soothsayer of folly (use the plural and in the emphatic form). The greatest of generals (use *summus* for greatest) has come to Rome on the Ides of March to punish the citizens.

LI.

Rise of Prussia (*continued*).

The Turkish empire had greatly increased in strength during the rule of Mohammed IV. His great achievement was the conquest of the beautiful island of Candia, which the Venetian republic defended for years with heroic but useless perseverance. Then followed several wars in which the Porte successfully combated Poland and Russia. At length a far more important contest began, when Kara Mustapha, the Grand Vizier, poured his troops into Hungary, declaring himself the protector of the rebel Tökely, whom he proclaimed ruler of the whole kingdom. The Turkish army drove back the Austrians before it across the frontier, invaded the Austrian territory, and in 1683 pressed forward to the walls of Vienna itself. The emperor fled to Passau, and the duchies of Austria, Steiermark, and Moravia were devastated alike by the Turks and the rebel Tökely.

Invasion of Austria by the Turks.

The garrison of Vienna consisted of only 12,000 men, and against these 200,000 Turks were encamped. But a number of the citizens, students and others did duty as soldiers; and Stahremberg, the governor, maintained the defence like a hero against these arful odds. The pressing danger, and the idea of the tremendous consequences that would accrue to Europe if the Turks became masters of Vienna, roused the estates of Germany to exert themselves to the utmost in raising an army

Siege and deliverance of Vienna.

to relieve Vienna; and John Sobieski, the chivalrous king of Poland, hurried thither with 20,000 Poles, and took the command of the combined relieving forces, with the Duke Charles of Lorraine and the Prince of Waldeck as leaders under him. On the 12th of September, 1683, the army under Sobieski gave battle to the Turks, and won a brilliant victory over them.

John Sobieski.

It was high time; for Vienna was in dire distress, and various of the outworks had already been captured by the enemy. It is a significant comment on the absurd length to which prescription and etiquette were carried at the Austrian court, that when the emperor, returning from Passau, met John Sobieski, the question was gravely debated, where and in what manner the emperor should receive his deliverer. The gallant Charles of Lorraine cried, "With open arms, if he has saved the empire." But the prescription insisted that the emperor could only receive the king of Poland in the open air, and on horseback; and the rules of etiquette were carried out accordingly.

CHARLES OF LORRAINE.

The invaders were now driven back into Hungary, where the war continued; the advantage being generally on the side of Austria. The defeat of the Turks at Mohacz, on the 12th August, 1687, definitely turned the scale in favour of Leopold. The object of the emperor in this all-important struggle was not only the humiliation of the Porte, but the acquisition of Hungary, for which the abortive insurrection furnished a welcome pretext. The object was attained; and at the diet of Presburg, in 1687, Hungary was declared to be one of the hereditary possessions of the Austrian house; it being stipulated, however, that each ruler should on his accession solemnly vow to maintain the liberties and privileges of the Hungarian nation.

Turkish defeat at Mohacz.

The Porte now experienced various military disasters; and the ill success of his arms cost Mohammed IV. his throne, to which his brother Solyman III., whom he had imprisoned, was now raised. A renewed attack on Germany by Louis XIV. compelled the emperor to withdraw part of his forces to face the new danger, and caused the scale to incline once more towards the Turks; but increased complications, and new enemies, the most notable of whom was the Czar Peter I. of Russia, increased the dangers and troubles of the Porte. Solyman's brother and successor Achmed II. was beaten by Louis of Bavaria in the battle of Solankemen, in 1691,—and at length, on the 11th September, 1697, the youthful hero Eugene of Savoy almost annihilated a Turkish army at Zenta. The cousin of the Turkish emperor, Mustapha II., the son of Mohammed IV., who led his army to battle in person, had for a time upheld the Porte; but now the pride of the Turks was broken, and they concluded a peace at Carlowitz, which was to last twenty-five years. The conditions of the treaty were highly favourable to Austria, and cost Mustapha his throne. He was deposed soon afterwards by a revolt of the janissaries.

Decline of the Porte.

Thus at the end of the seventeenth century the empire had triumphed over the Porte, whose power in Europe was declining, while on the other hand the house of Hapsburg had fared but badly in the struggle against the power and supremacy of France. The beginning of the eighteenth century saw the house of Hapsburg engaged in the great war of the Spanish succession, on behalf of the Archduke Charles, who by the death of his elder brother unexpectedly became emperor with the title of Charles VI., and for whom Eugene of Savoy fought as valiantly and faithfully against Louis XIV. as he had fought for Leopold against the Turks. At the

Eugene of Savoy.

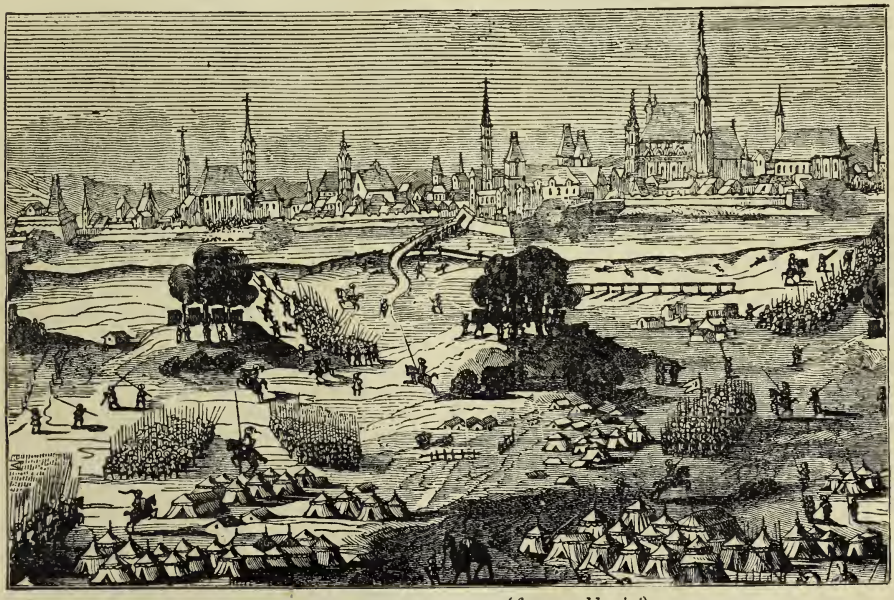
same time, in northern Germany another struggle was going on, involving the rise of a house destined at a later period to take the lead in the affairs of Germany.

Sweden had been the kingdom that had perhaps profited most by the Thirty Years' War. Though weakened for a time by the loss of the heroic Gustavus Adolphus, that power had still continued to maintain a footing in Germany, through the wise rule of the council of regency under Axel Oxenstierna, during the minority of the young queen Christina, the daughter and successor of Gustavus. The nobles gained great influence during this period, Oxenstierna himself setting them up as a counterbalancing power to the peasants, who were becoming more and more discontented at the continually increasing taxes. When Christina took the government into her own hands, she surrounded herself with a brilliant court, and propitiated the nobles by large grants of land. At the treaty of Westphalia Sweden received the duchies of Bremen, Verden, a large portion of Pomerania, besides Weimar and various other important possessions. Much discontent prevailed among the people, whose old independence was gone; and in disgust at the difficulties of her position, Christina, by a hasty abdication, in 1654, which she is said to have afterwards deeply regretted, transferred the throne to her cousin the Palsgrave of Deux-ponts or Zweibrücken, who ascended the throne with the title Charles X. He was a bold, warlike prince, and carried on war successfully against Poland, Russia, and Denmark; gaining much territory,

Sweden after Gustavus Adolphus.

Queen Christina.

Reign of Charles X.



SIEGE OF VIENNA BY THE TURKS (*from an old print*).

especially from the last of these three powers. On his death, in 1660, he was succeeded by his young son Charles XI., during whose minority the dowager queen Hedwig Eleonora carried on the government. Sweden continued to maintain war, generally with success, against Denmark, Poland, and Russia, which powers were converted into her deadly enemies. When he took the reins of government into his own hands, Charles XI. showed himself capable of ruling wisely. He saw the necessity of peace and rest for the country, and though gallant and chivalrous, avoided war where he could, and sought to consolidate the power of his country by the arts of peace, fostering learning and science, founding colleges and schools, and laying up a considerable treasure in coined money against a day of danger. He died too early for the welfare of his country, leaving the crown to his son Charles XII., a youth of fifteen, destined to experience the utmost vicissitudes of fortune, and ultimately to leave

Charles XI.

Accession of Charles XII.

> "A name at which the world grew pale,
> To point a moral and adorn a tale."

Meanwhile a power in northern Germany was rapidly rising into an importance which excited the jealousy alike of Austria and Saxony. The marquisate of Brandenburg, with its capital Berlin, was ruled from 1640 to 1688 by Frederick William, known as the "great elector," one of the most distinguished princes of his century. At the peace of Westphalia he received the district of Magdeburg and other territories, though he was obliged to cede the greater part of Pomerania to the Swedes. By

Rise of Brandenburg.

the treaty of Oliva, in 1660, the sovereignty of the duchy of Prussia was guaranteed to him. At a later period he fought valiantly against the threatened supremacy of Louis XIV., and in 1675, by his great victory of Fehrbellin over the Swedes, put an end to the power of that nation in North Germany. In 1679 he drove them out of Prussia, but the weak desertion of his cause by the emperor compelled him to relinquish many advantages that he had gained. He was succeeded at his death by his son Frederick, who in 1701 converted the marquisate of Brandenburg and the territories thereunto belonging into a kingdom, and with the reluctant consent of the Emperor Leopold became the first king of Prussia.

The great Elector Frederick William.

KEY TO FRENCH EXERCISES.

EXERCISE XLI. (*page* 243).

1. Does she at last consent to it?—No, she does not consent to it, she objects to it. 2. What did you put into it?—I put nothing at all into it. 3. Are you going to Burgundy this year?—I am going there (*or* to it), but I do not intend to make a long stay there. 4. One has cheated me (*or* I was cheated) in that shop; I shall no more return to it. The tradesman did not look honest; you ought not to have trusted (*yourself to*) him. 5. I read and read again this page, and I do not find any error in it.—Yet, there is one. 6. You see that house over there?—Yes Well, we shall spend the summer in it. 7. If it is a letter from Theresa that you have just received, do not fail to answer (*to*) it to-day.—I have already answered it. 8. Is Mr. Dupré at home?—Yes, sir, he is (*there*), but visitors are not admitted; he is ill. 9. If they approach the bank of the river too near, they will fall into it.—If they fall into it, they will get out of it; they swim like fishes. 10. Is it enough? tell me; will this not do yet?—No. This will do then?—Not at all. That will do. You do not come near it. 11. How much do you bid for it?—I bid nothing for it, I am not in need of it. 12. Here are bananas and dates which I have just bought: do you wish to have some (*of them*)?—Be so kind as to give me some (*of them*). 13. How do you like these wild cherries? Shall I pass you a few *kilos* of them?—I shall be very glad to take half a dozen *kilos* of them. 14. Where are you going?—I? I am going to the country; are you coming from it?—No, we are not coming from it. 15. He asked you for some cranberries, and you have given him some.—Of course: why should I not have given him some? 16. Do you remember the words of his letter? I have remembered the contents of it.—I have forgotten both the words and the contents of it. 17. Have you brought back flowers from the garden?—Yes, we have brought back some. 18. Did they read any French to-day?—No, they have not yet read any. When will they read some?—They will read some to-morrow. 19. Has she a medlar?—No, she has not any. Yes, she has one (*of them*). 20. Why does one complain of him (of her, of them, *m.*, of them, *f.*)?—One does not complain of him (of her, of them, *m.*, of them, *f.*)

EXERCISE XLII. (*page* 244).

1. Nous y consentons, si elle s'y refuse. 2. La cuisinière n'y a mis que du poivre. 3. Je vais en France cet hiver, que vous y alliez ou non. 4. Ce marchand n'a pas l'air honnête, ne vous y fiez pas; évitez sa boutique; n'y retournez pas. 5. Le maître dit qu'il a lu cette page, et qu'il n'y trouve pas de faute. 6. Essayez cet hôtel-là; j'y ai passé une fois une quinzaine. 7. Répondez à la lettre qui vient d'arriver, répondez-y sur-le-champ. 8. Madame Dupré est-elle chez elle?—Non, monsieur, elle est à la campagne. Depuis quand y est-elle?—Une quinzaine. 9. Ne vous approchez pas de la rivière, vous y pourriez tomber. 10. Vous y êtes, mon cher ami. 11. Combien en avez-vous offert? 12. Me céderez-vous des oranges et des citrons si vous en avez plus que vous n'en avez besoin? 13. Je ne crois pas que ce raisin soit bon; je n'en prendrai qu'une demi-douzaine de kilogrammes. 14. Revenez-vous de la campagne?—Oui, j'en reviens. Les routes y sont-elles mauvaises?—Ne m'en parlez pas.* 15. Quant aux fraises et aux groseilles, si l'on en demande, donnez-en. 16. J'en ai oublié le texte, mais j'en ai retenu l'esprit. 17. Des mûres! apportez-nous-en donc une petite assiettée. 18. Demandez-lui si elle a lu de l'italien aujourd'hui. Demandez-lui s'il en a lu. 19. Si je reçois une poignée de glands, en recevra-t-elle une aussi? 20. On se plaint de lui et de nous.

EXERCISE XLIII. (*page* 344).

1. Elle me le vend; elle me la vendait; elle me les vendit. 2. Je te les vends; je ne te la vends pas; est-ce que je te le vends? est-ce que je ne te les vends pas? 3. Ils nous les rendent; ils nous le rendaient; ils nous la rendirent. 4. Nous vous les rendons; nous ne vous la rendons pas; vous le rendons-nous (*or, and this is here the more usual practice,* est-ce que nous vous le rendons)? ne vous le rendons-nous pas (*or* est-ce que nous ne vous le rendons pas)? 5. Je les lui fendrais; tu les lui fendrais; il les leur fendrait. 6. Je veux que vous me les pendiez; je veux qu'il te le pende; je veux qu'elle nous la pende. 7. Il voudrait que je le lui tondisse; il ne voudrait pas que nous les lui tondissions; elle voudrait que vous lui tondissiez ces moutons. 8. Je vous les fondrais si vous vouliez me répondre. 9. Il m'en vend; je t'en vends; tu lui en vends; nous lui en vendons; vous leur en vendez; ils vous en vendent. 10. Vous ne m'en rendrez pas; m'en rendrez-vous? 11. Il m'y attend; je ne t'y attendais pas; elle l'y attendit; il ne

* Had the sense been complimentary, as with *les routes y sont-elles bonnes?* "I can vouch for that" would have been rendered, *e.g.*, by *je crois bien.*

l'y attendit pas. 12. Vous y attendrions-nous (*or* est-ce que nous vous y attendrions)? 13. Descends-le-moi; descends-le-lui; descends-les à ton oncle. 14. Vendons-les-lui; ne la leur vendons pas. 15. Qu'il le torde; qu'il lui réponde; qu'il vous morde; qu'il ne l'entende pas. 16. Rendez-m'en; rendez-lui-en; rendez-nous-en. 17. Attends-m'y; ne l'y attendons pas. 18. Je désirais qu'il vous répondît; je désirais qu'elle répondît à mes lettres.

EXERCISE XLIV. (*page* 438).

1. Here is our carriage coming; where is yours?—I have not ordered (did not order) mine; I shall ride. 2. I tell you that my cousin and yours (pl.) are right. That is your opinion, but it is not ours. 3. Do you wish to be one of our party?—I do not mind. 4. You have seen (you saw) my library and his; do you like them better than theirs?—Your libraries are very good, but theirs is better. 5. Is it of my pencil or yours that you make use (is it my pencil or your own you are using)?—I make use of mine, there is yours. 6. Make them understand that my views do not differ from theirs. It is not my business, it is thine. 7. With which penknife have you mended (did you mend) your quill? with his?—No, I mended it with mine. 8. Did she tell you that she was writing to my sisters after having written to yours?—She told us nothing. 9. She did not communicate her project to me because I did not wish to communicate mine to her.* 10. Did you think (have you been thinking) of my affair?—No, I have not been thinking of it; I have only been thinking of mine. 11 Boy, what is there in your basket?—I have two ducks and three geese in it. 12. Are your sucking-pigs for sale?—They will not be so for three weeks. 13. Give my respects to your grandmother, and beg her to accept this (young) hare and this brace of (young) partridges. 14. Are your turkey-cocks, ganders, and peacocks as big as mine?—I should think so. 15. The Marquess of Carabas presents his compliments to your Majesty, and begs you to be so kind as to accept three warren rabbits and a brace of (young) pheasants. 16. Had your father good sport?—Oh, he did not return home unsuccessful; his game-bag was overflowing with hares and partridges. 17. How old should you say my she-ass is?—To judge by her teeth she must be about fifteen years old. 18. The wild sow and her young were wallowing in a pool. 19 Your father related to me his adventure with the she-wolf and the cubs. 20. My goat has lost her kid; thy ewe has lost her lamb; would our cow lose her calf?

EXERCISE XLV. (*page* 439).

1. Se sert-il de ma voiture ou de la sienne? Il se sert de la mienne. 2. Etes-vous d'avis que votre père a raison et que le sien a raison? Je suis d'avis que mon père n'a jamais tort. 3. Dites-vous que votre sœur ne sera pas des nôtres? Elle voudrait bien êtres des vôtres, mais sa santé ne le permet pas. 4. Préférez-vous notre lévrier au vôtre? Je préfère le mien au vôtre. 5 Se serviront-ils des poulains et des pouliches. 6. Fais-lui comprendre que ses vues sont aussi les miennes. 7. Avez-vous taillé cette plume avec son canif ou avec le vôtre?—Avec le mien. 8. Doit-elle écrire à sa sœur après avoir écrit à la mienne? 9. Vous a-t-elle fait part de mon projet ou du sien? 10. Je lui ai dit que je n'avais pensé ni à son affaire ni à la tienne. 11. Ma petite, qu'est-ce qu'il y a dans ta hotte? J'y ai des poulets et des pigeonneaux. 12. Il a un serin et une serine à vendre. 13. Mon maître vous fait ses compliments et vous prie d'accepter une couple de faisans et un levraut. 14. Mon garçon, fais bien mes compliments à ton maître, et fais-lui mes remercîments. 15. Leurs majestés le roi et la reine font leurs remercîments au Marquis de Carabas. 16. Votre père (*or* monsieur votre père), a-t-il fait chou blanc (*or* est-il revenu bredouille)? Non, il a tiré un cerf, un chevreuil, et deux daims. 17. A juger par les dents de votre jument, je ne lui donnerais pas plus de quatre ou de cinq ans. 18. Nos porcs se vautrent dans votre mare. 19. Madame (*or*, *as the case may be*, mademoiselle) votre tante nous avait raconté son aventure avec le singe qui s'était saisi de sa colombe. 20. La ménagerie de M. W. contient deux lions, trois lionnes et leurs lionceaux, une couple d'ours, un tigre royal, et le petit d'une renarde qui est morte depuis peu.

EXERCISE XLVI. (*page* 531).

1. L'abeille, la sauterelle, le cri-cri—tout bourdonne et chante en été. 2. Le coucou criait au printemps; je voudrais que le coucou criât. 3. Le hanneton, aussi bien que l'abeille, la mouche et le colibri, bourdonne. 4. Les hiboux chuintent ou huent; je voudrais que l'hibou huât. 5. Les corbeaux croassaient dans les arbres, les grenouilles coassaient dans l'étang. 6. L'alouette grisolle, le geai cageole, le merle siffle, le pinson ramage, seul le rossignol chante. 7. Dire que les merles, le serpent et l'oie sifflent, trahit une certaine pauvreté de la langue. 8. Les crocodiles mangent de la chair et du poisson; les éléphants mangent de l'herbe. 9 Les cigognes commenceront à bâtir dans une quinzaine; mangeront-elles toutes les grenouilles? Elles les mangeront. 10. Le moineau pépie même en hiver. 11. Nous les dérangeons; nous y songions; nous y plongeâmes nos bâtons; nous vous soulagerons; nous pataugerions. 12. Je voudrais qu'il les engageât à déloger. 13. Vous commencerez à vendanger mardi prochain; je veux que vous vendangiez lundi prochain. 14. Il la menace; il les plaçait; il le tança vertement; il le lancera. 15. Nous ne vous forçons pas; nous ne le pincions pas; ne sucez donc pas votre pouce. 16. J'en emploie; tu en noies; il n'en broie pas; elle en plie plus que vous. 17. Que nous les essuyions; que vous ne nous ennuyiez pas; ils balayaient; comme cet homme grasseye! comme cette femme coudoie le monde! 18. Nous ne les pliions pas, nous les liions; je ne dis pas que vous suppliez, mais que vous suppliiez. 19. Il le délie; il ne le reliait pas: ne le renonça-t-il pas? 20. Il grée un brick; nous gréons notre barque; agréez l'expression de mes regrets.

* The words *lui faire part* were unfortunately omitted here.

SOUND, LIGHT, AND HEAT.

IX.

LIGHT (*continued*).

ANOTHER very curious phenomenon resulting from the rectilinear propagation of light is that seen when the rays of light from any object are caused to pass through a very small aperture, such as a hole in a shutter, or a pinhole in a piece of cardboard. If into a darkened room the rays of light from external objects be allowed to pass through a small hole in a shutter, and be received upon a screen, the images of these external objects will be perceived upon the screen in their natural colours, but *upside-down*. (*See* fig. 41.) This is the secret of the camera obscura, with the

Inverted images formed by a small aperture.

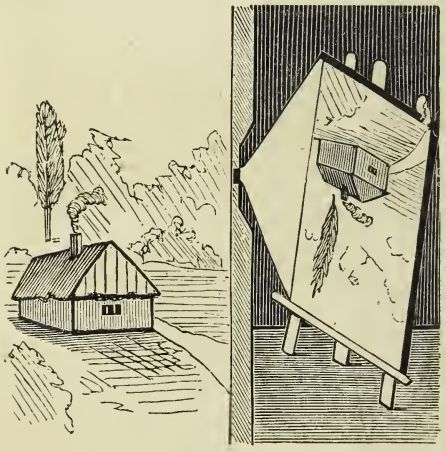


FIG. 41.

exception that in that amusing apparatus a lens or series of lenses is employed so as to cause the pictures to appear in their natural position instead of inverted.

The camera obscura.

This apparently wonderful phenomenon is easily explained by the knowledge of the fact that light is propagated in straight lines. Take an opaque screen having a small aperture. If any object, such as an arrow, be held outside the aperture, the rays from the two extremities of the arrow will obviously cross each other, and an inverted image of the arrow will be formed upon the screen.

Explanation of inversion of images.

A simple but pleasing experiment in illustration of this inversion of images is the following. Take a piece of cardboard and make in it, about its centre, a rather large pin-hole; if now you hold it between a candle or lamp and a small screen, an inverted and enlarged image of the flame will be formed on the latter. (*See* fig. 42.)

A simple experiment.

When light passses through the chinks of a nearly closed Venetian blind it forms images of the sun upon the floor, which are oval in form, and the same phenomenon occurs when the sun is seen shining through the leaves of a dense forest. The elliptical shape of these images is due to the fact that the screen upon which they are received is inclined at an angle to the path of the sun's rays.

If in the experiment with the candle-flame

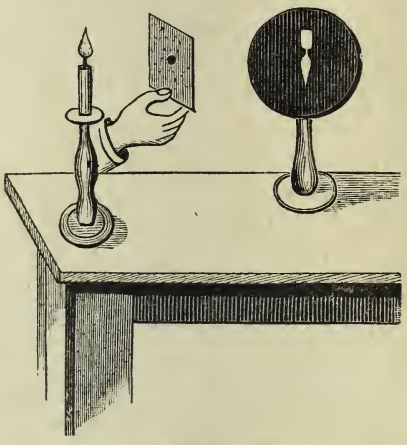


FIG. 42.

and the perforated cardboard, the hole be gradually enlarged, the image will at first get brighter and brighter, and at length altogether disappear, being replaced by a brilliantly and uniformly illuminated surface. It is only *small* apertures which by sufficiently dividing the light give rise to these inverted images; when large openings are used the rays of light coming from all parts of the object overlap and form no definite image.

Inversion only possible when small apertures are employed.

We all know that the intensity of light varies

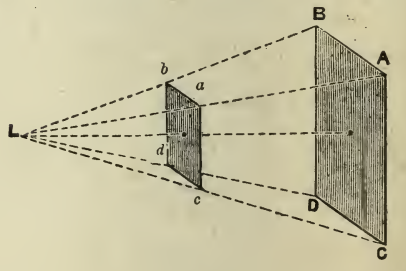


FIG. 43.

with the distance from the source from which it comes, but by means of shadows we may verify the exact law which governs its variation. The source of light should be a strictly geometrical point, but with an ordinary candle-flame the following experiment will be found to succeed very well. Let a candle be placed as at L (fig. 43), and a card-

Variation of the intensity of light with the distance.

board screen, say at a distance of two feet from the candle. Take a piece of paper the exact size of the cardboard screen and fold it carefully into four ; if placed at a distance of one foot from the candle (that is, midway between it and the screen), it will be found that the shadow of *a b c d* will exactly cover the screen, A B C D, which is four times as large. Variations of this experiment will show that the same law holds true for light as for sound—namely, that *the intensity varies inversely as*

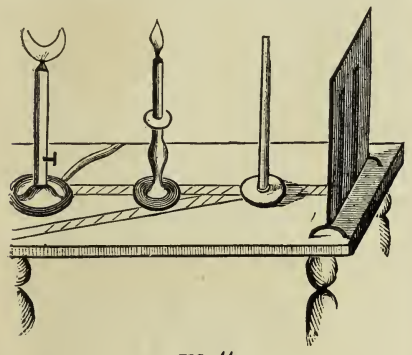


FIG. 44.

the square of the distance. A full explanation of this law has already been given in the chapters on "Sound."

This important law affords us a ready means of determining the relative illuminative powers of various illuminating agents. This branch of optics is termed "Photometry" (Greek *phos*, light; *metron*, a measure). The reader may devise a simple experiment to illustrate this method of gauging the illuminating powers of different bodies. Place a rod in front of a screen, as in fig 44, then take two lights, such as a lamp and a candle, and place them in such positions that

Photometry.

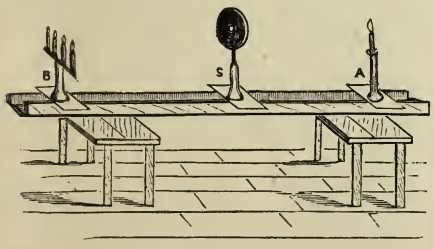


FIG. 45.

the two shadows of the rod are of *equal intensity* ; now measure the respective distances of your two sources of light from the screen, and their respective illuminating powers will be to each other as the squares of their respective distances ; this is Rumford's system of photometry.

A form of photometer much in use is that known as Bunsen's, from the name of its inventor. It is shown in fig. 45. It consists of a circular frame, upon which is stretched a piece of white

Bunsen's photometer.

paper, S, in the centre of which is a spot of grease formed by stearine. The lights are placed at each end of a scale, and along that scale the screen is moved until the spot of grease becomes invisible. This will obviously be when the amount of light on each side of the spot is exactly equal, for if a stronger light is behind, the spot will appear bright upon a dark ground, while if the stronger illumination be in front the spot will appear dark on a bright ground. The distance of the screen from each source of light is then measured, and their relative illuminating powers determined by the law of inverse squares as before.

We must now turn our attention to the reflexion of light, and the law by which regular reflexion is governed. All bodies reflect light, and it is only by this reflexion that opaque objects are visible to us ; but such bodies as the page upon which this is printed reflect the light which falls upon them in every direction so as not to form an image, but to give rise only to the impression of a generally illuminated surface ; such reflexion is termed *irregular*

Reflexion of light.

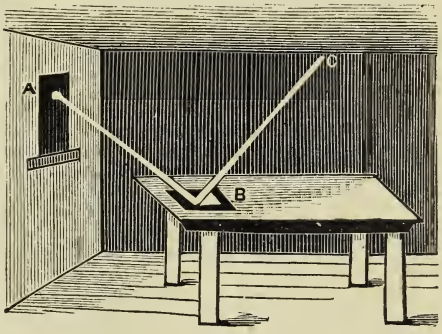


FIG. 46.

Smooth surfaces, such as glass or polished metal, reflect light in a perfectly regular manner, and in a perfectly definite direction. This so-called "regular" reflexion is that which we are about to consider.

The law which governs the regular reflexion of light is the same as that which has been fully explained in the chapters on "Sound," to which it also applies. It is as follows : *The angle of reflexion is always equal to the angle of incidence; and the incident and reflected rays are always in the same plane.* Fig. 46 will assist in making the exact meaning of this law clear. Let A B represent a beam of light falling upon any polished flat surface, it will be reflected in a direction B C. A B is the *incident ray*, B C the *reflected ray*. If a perpendicular, D B, be drawn, it will be found that the angle A B D is always equal to the angle D B C. The former is the *angle of incidence*, the latter the *angle of reflexion*. Finally, the plane A B C—that is the plane of the paper—is the plane containing both incident and reflected rays.

Law of reflexion of light.

IX.

THE SECOND PERIOD OF ENGLISH LITERATURE.

From the Death of Chaucer to the Accession of Queen Elizabeth.

(1400—1558.)

The fifteenth century was not in England a time propitious to genius and learning. It may rather be called a period of reaction and humiliation so far as literature and general enlightenment are concerned. The writer of the fifteenth century could not, with any regard for his own safety, allow his satiric fancy to sport, as Chaucer's did, with such legitimate subjects for satire as clerical sloth and priestly imposture. The heavy hand of ecclesiastical tyranny lay with ruthless weight upon the community. The persecution of the Lollards, begun under Henry IV., continued through the time of his successors. Such an outspoken poet as the author of *The Vision of Piers Plowman*, or even the author of *The Canterbury Tales* himself, would have been in danger of having his heresies shortly and sharply dealt with by the executioner. Religious persecution began in England in the fifteenth century. It commenced at a time when the nation had only just awakened into intellectual activity—an activity that showed itself mainly in the direction of religious inquiry. "Things bad begun make strong themselves by ill;" and Henry IV., to strengthen the foundations of his usurped throne, bought the favour of the clergy by placing in their hands the unhallowed weapon of persecution. Never was a more complete illustration of the truth put by Shakespeare into the mouth of the legate Pandulph, declaring that—

Barren period after Chaucer's time.

Religious persecution under Henry IV.

> "A sceptre, snatched with an unruly hand,
> Must be as boisterously maintained as gained;
> And he who stands upon a slippery place
> Makes nice of no vile hold to stay him up."

The torch of persecution thus lighted in England for a time blazed up fiercely. Wickliff had done a great national service by his translation of the Scriptures; but that costly legacy was snatched from the hands of his countrymen. For more than a century the Bible became once more a sealed book to the community at large; and ignorance and superstition had another lease of life. It has been well remarked that the English mind had already shown, even amidst its comparative barbarism, a stern independent spirit of religion, and from this single proud and elevated point of its character it was now to be crushed and beaten down. Sometimes a baffled struggle against tyranny is more depressing to the human faculties than continued submission.

Bad effects on literature.

But the day of emancipation was to come, surely and fully, though the time was not yet. To Henry IV. might be applied the words of scathing anger hurled by Gray's Bard at the supposed murderer of his companions:—

> "Fond, impious man! Think'st thou yon sanguine cloud,
> Raised by thy breath, hath quenched the orb of day?
> To-morrow he repairs the golden flood,
> And warms the nations with redoubled ray."

That morrow came when, in the glory of the Elizabethan era, the nation forgot the long years of havoc that "ran their destined course" in the Wars of the Roses, and the confusion of change that distracted the country during the reign of all but the last and greatest of the Tudor sovereigns. There was another cause that veiled the morning of English poetry and literature generally after it had dawned brilliantly with Chaucer—for that bright hour of dawn was succeeded by a cold and inclement morning; or, to quote the capital illustration given by Warton in his *History of English Poetry*, "Chaucer may be considered as a genial day coming early in an English spring; its cloudless skies, brilliant sun, and sudden warmth, fill our hearts with the visionary prospect of a speedy summer, and we fondly anticipate a long continuance of gentle gales and vernal serenity." But the genial day was but an exceptional phenomenon, to be followed by renewed glooms of winter, and by nipping frosts and searching and eager winds. Thus the immediate successors of Chaucer seem associated rather with the harsh wintry rigour that preceded him than with the genial glow of spring diffused around him by the Father of English Poetry. The night of barbarism and ignorance descended again upon England during the fifteenth century, not to be dispelled until the sun of genius rose more brightly than ever, in the full radiance that illuminated the glories of the Elizabethan era.

Chaucer's standard of excellence not maintained.

Religious persecution was the first great reason of the literary darkness of England; in the wars of York and Lancaster we find the second. The patronage of the great was in those days the very breath of life to the poet and the scholar. It was in the sunshine of princely favour that the flower of poetry unfolded its petals; as in a former age, an Augustus and a Mæcenas were necessary to the well-being of a Virgil, a Horace, or an Ovid. In Italy, at the period in question, this patronage was ungrudgingly, nay, liberally given. Such rulers as the Medici of Florence considered the patronage of the poets of Italy at once their duty and their prerogative; but in England princes and nobles were employing all their energies, straining their means, and pledging their credit in prosecuting the great struggle of the rival claimants to the throne. They had neither time nor attention nor assistance to bestow on scholars and bookmen; and so great was the demoralization

Italy and England in the fifteenth century contrasted.

produced by the civil wars, that, to quote a high authority on the subject, "if we add to the political troubles of the age the circumstance of religious opinions being silenced and stifled by penal horrors, it will seem more wonderful that the spark of literature was kept alive, than that it did not spread more widely. . . . Whilst in England the public spirit was thus brutalized, whilst the value and security of life were abridged, whilst the wealth of the rich was employed only in war, and the chance of patronage was taken from the scholar, in Italy princes and magistrates vied with each other in calling men of genius around them as the brightest ornaments of their states and courts." In our northern clime the day dawned later than in sunny Italy, or even in France; but when it came, its splendour rivalled that of the southern land of the vine and the olive.

Still, the century and a half that intervened between the death of Chaucer and the time of Elizabeth was not destitute of writers of merit, both in poetry and prose; nor do the merits of several of them seem to have been appreciated by our earlier commentators and collectors. A certain stiffness and quaintness of style, and a decided tendency to minuteness of detail that frequently becomes tedious, have been allowed to weigh perhaps too heavily against the sterling qualities to be found in the works of such writers as OCCLEVE and LYDGATE, and in a higher degree in the lyrics of the accomplished EARL OF SURREY, and of various northern poets, foremost of whom stands GAWAIN DOUGLAS, son of the redoubtable "Bell-the-Cat." It was not until Addison pointed out what a store of genuine poetry lay mingled with the dross of such writings as the old *Chevy Chace*, that the English ballad was truly recognized as a literary form in England; and not until even a later period were the qualities of Chaucer's successors recognized; Gray, Coleridge, and the talented author of *The Amenities of Literature* sharing largely in the credit of drawing attention to them. Thus, on the whole, though this second period did not produce a Chaucer or even a "Master Richard Gower," it is far from being an entirely barren and unprofitable tract in the literary history of England. In the latter part especially,—the reign of Henry VIII., —we find a transition into a new era; a preparation, as it were, for the great epoch that was at hand. That learning received but little patronage from the great during this second period, and that Chaucer's idea of making the Clerke of Oxenford ride on a horse "lean as is a rake" was founded on fact, is evidenced by many signs. The wars disturbed the course of all ordinary civil life. Persons of all professions and callings, even clergymen as well as laymen, were called into the field. While the best livings became the prizes or bribes for the assistance of foreigners or powerful but illiterate men, the best scholars from both Universities were begging their bread; and many were the complaints of Oxford and Cambridge to Parliament concerning this grievance. The poor scholars became the jest and byword of the Front-de-bœufs and Malvoisins of those rude days. Among many similar stories illustrative of the slight esteem in which they were held, it is told how two of these learned mendicants came to the castle of a baron with recommendations from their University. The noble, understanding from their credentials that the travelling scholars had a taste for poetry, commanded his servants to put one scholar into one of the two buckets of the castle well, and the other into the twin bucket, and let them down alternately into the water until each should make a couplet of verses on his bucket. The anecdote further tells that after enduring this discipline for a considerable time, to the great entertainment of the baron and his company, the two scholars made the required verses, and were set at liberty. A notable instance, this, of the honour in which learning and its professors were held in the fifteenth century in England. Indeed, even in later times, "it was thought enough for a nobleman's sons to winde their horn, and to carry their hawk fair, and leave study and learning to the children of mean people." Those were not the days when the pen was more powerful than the sword. One great exception to this rule, that confined learning to the "children of mean people," was found in the admirable and learned John Tiptoft, Earl of Worcester, in his youth a student of Balliol College, Oxford, who gained not only an English, but likewise a continental reputation for his learning, at Rome, Padua, and elsewhere. "O good blessed Lord God!" exclaims Caxton, on hearing of the execution of this phœnix among the nobility in the Wars of the Roses; "what grete losse was it of that noble, virtuous, and well-disposed lord, the Earl Worcester! What worship had he at Rome, in the presence of our Holy Fader the Pope, and in all other places unto his deth! The axe did then at one blow cut off more learning than was in the heads of all the surviving nobility!" Thus the old English printer seems at once to attest the learning of this Earl of Worcester, and the general ignorance of the nobility of England.

Style of the fifteenth century stiff and tedious.

Some writers of eminence.

Wars of the Roses; learning despised.

Earl Tiptoft, a patron of learning.

The language of this second period was subject to considerable change. William Caxton, writing in 1490, says: "Certainly, the language now used varyeth ferre from that which was used and spoken when I was born. For we Englishmen ben borne under the domynacyon of the mone, which is never stedfast, but ever waverynge." The language of the common people, indeed, varied so greatly in different parts of the kingdom, that the dialect of one part of England was almost unintelligible to the inhabitants of another; and again, the polite and learned employed a number of terms of which an "uplandish" man or provincial might have said, as Casca of Cicero's remarks on the Lupercal, "It was Greek to me." Caxton himself appears to have been at times sorely puzzled in the choice of words in his various

The English language of the sixteenth century.

translations, wishing at once to please the learned and to be "understanded of the people." Thus he tells us: "Some gentylmen have blamed me, saying that in my translacyons I had over curyous termes, which could not be understande of comyn peple, and denied me to use old and homely terms in my translacyons; and fayn wolde I satisfy every man. But some honest and grete clerkes have been wyth me, and desire me to wryte the moste curyous termes that I coude fynde. And thus, between playn, rude, and curious, I stand abashed."

Caxton's English.

XXV.

Voltaic Electricity (*continued*).

In order that we may be able to obtain a correct knowledge of the relation to each other of the resistances of different conductors, it is necessary that we should have instruments by which resistances may be accurately measured; and we will now proceed to a description of some of the most useful instruments employed in these measurements.

Measurements of resistances.

The first of these which we shall describe is the "rheostat," which is employed to alter the resistance in a circuit without breaking the connections. It is shown in fig. 88, and consists of two

The rheostat.

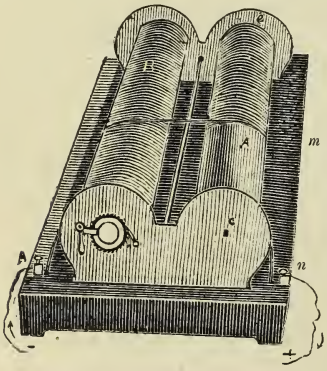


FIG. 88.

cylinders arranged parallel to each other, one of these cylinders being of glass, wood, or other non-conducting material, and the other of metal. Grooves are cut upon the non-conducting cylinder, and in these grooves a brass or copper wire attached to the axis of the cylinder is wound. The other end of this wire is wound round the metal cylinder with its turns in an opposite direction to those on the insulated cylinder so that if the wire be wound off one cylinder it is wound up on the other, and thus the relative proportions of the wire on the two cylinders may be regulated at will. The ends of the wire are attached to the axes of the cylinders, as may be seen from the figure. Connected with the cylinder A is the binding-screw *n*, and with the cylinder B is another binding-screw; to these screws the battery wires may be attached, and thus the rheostat placed in the circuit.

The action of this instrument depends upon the fact, that when a wire through which a current is passing comes into contact with a large mass of metal or other conducting material, the current passes directly through the conductor. Consequently, when a current reaches the rheostat, it will only pass through that portion of the wire which is wound upon the non-conducting cylinder B. From B it will pass to *m*, and thence to *n*, so that the only part of the wire which is in the circuit is that which is coiled on B, together with the portion which passes from B to A. It is evident that by uncoiling wire from B to A the resistance of the circuit will be *decreased*, while by the reverse process it is *increased*. This is effected by the handle shown in the figure, which must be turned from right to left when the length of wire in the circuit is to be increased, and in the opposite direction when the resistance is to be decreased. The length of wire uncoiled is denoted by a dial not shown in the figure.

Principle of the rheostat.

A modification of the rheostat is the *rheocord*, which is an instrument used when the current is very intense, and where, therefore, the rheostat cannot be employed because of the necessary thinness of its wire. It is shown in fig. 89, and consists of a board on which two uprights, E and F, are erected, and between these uprights a German silver wire *a b c* is stretched double, so as to lie horizontally between its supports. Upon it is threaded an iron thimble, G, through two holes in the top of which the wire tightly passes, and the thimble which is thus made movable on *a b c* is filled with mercury. Now, in accordance with the principle upon which the rheostat depends, it will be easily seen that when a current enters the wire at *a*, it will pass along the wire until it reaches the thimble of mercury, G, through which it will pass and return to *c*, not traversing that part of the wire which lies between G and B. Consequently, the nearer G is to E the less distance of wire will the current have to traverse in passing from A to C, and *vice versâ*. In this way the rheocord, like the rheostat, may be employed to regulate the amount of resistance in a circuit without breaking the connection.

FIG. 89.

The rheocord.

Resistance in wires.

Before proceeding to describe a very important instrument for measuring resistances, "Wheatstone's Bridge," it will be necessary for us to briefly notice one or two points connected with the resistances of wires.

In the first place, it is found that if we take a number of wires each having different resistance, and join them end to end, the resistance of the whole series will be the sum of the resistances of the individual wires. Thus suppose we have six such wires, having resistances represented by the numbers 2, 3, 6, 7, 4 and 8, the total resistance of the series, joined end to end, will be represented by the number 30. Again, if the wires instead of being joined end to end, are arranged side by side, and one set of ends joined to the positive and the other set to the negative pole of the battery, it will be found that the conductivity of the whole is the sum of the conductivities of the separate wires. Inasmuch as we may consider any prismatic conductor to be made up of an indefinite number of minute prisms lying side by side, it follows that if you have two wires of the same length and chemical nature as each other, their resistances will be inversely as their sectional areas inversely, that is, as the number of imaginary prisms of which we may conceive it to be made up. Putting the results of these two investigations together, we may say the resistance of a cylindrical or otherwise prismatic conductors varies directly with its length and inversely with its sectional area. It must be carefully remembered in comparing the resistances of wires by noting their respective diameters, that the *areas* of circles vary directly as the *squares* of their diameters, consequently with two wires one having twice the diameter of the other, the resistances will be as 1 to 4, and not as 1 to 2

Relation of current to resistance.

Another important feature in the resistance of a bundle of wires such as we have imagined above is the relation of the current passing through each to their resistance. If we have, as just now supposed, a bundle of wires of different resistances lying parallel to each other, and joined up to the poles of a battery, the current from the battery will divide, and will pass along the different wires in quantities varying inversely as their respective resistances, the greatest proportion of the current going along the wire having the least resistance.

Wheatstone's Bridge.

Having made ourselves acquainted with the foregoing facts connected with the resistances of conductors, we will next pass on to the consideration of the instrument by which the electrical resistances of different conductors may be ascertained. This instrument we have already referred to as Wheatstone's Bridge, or the Electric Balance; we will first describe its construction, and subsequently investigate the principle of its action. A diagram of the Bridge as usually constructed is given in fig. 90.

Upon a piece of well-seasoned board M are placed three strips of thin brass or copper about half an inch in width, which are fastened as shown at A, B, and D, a break being left at both ends of A, and also between B and D. From B to D a thin German silver wire, which should be uniform in thickness and free from flaws, is stretched, and soldered to the brass or copper strips at each end. Underneath this wire a paper scale accurately divided into a

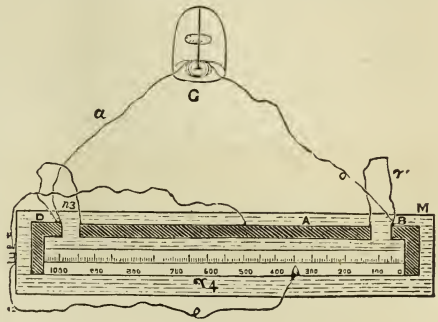


FIG. 90.

thousand parts is placed. Should the length of the wire be, as is usually the case, a metre, the divisions will of course be millimetres; but there is no necessity for the wire to be of any definite length, all that is required is that it should be accurately divided, the measurements to be taken from it being, as will presently be seen, not absolute but comparative. German silver wire is usually employed because its conductivity is but little affected by variations in temperature. An ebonite block C, provided with a metal pin, is made to slide along the board, and is connected with a wire, the other end of which may be attached to one pole of the battery or to a galvanometer. The metal pin is usually provided with a spring so that it may be pressed down upon the wire or not, at pleasure, thus forming a ready means of making or breaking the circuit. To the middle of the strip of copper A, a binding-screw is attached, and to this is fastened one of the battery wires. Binding-screws are also attached to the two ends of A and to the adjacent ends of the side strips B and D. In these binding-screws strips of wire, r_1, r_3, can be placed so as to fill up the breaks between the side strips and the ends of the longitudinal strip A. B and D are connected with a delicate astatic galvanometer G. This being the construction of the Wheatstone's Bridge, its mode of action will be perhaps better understood by a reference to fig. 91.

Principle of Wheatstone's Bridge.

Let A, B, C, and D, represent four conductors with breaks in them at *a*, *b*, *c*, and *d*, in which certain resistances may be introduced. Moreover, let the points A and C be connected with the terminals of a battery, and the points B and D with a delicate galvanometer G. Now if we suppose in the first place that the four resistances *a*, *b*, *c*, *d*, are all equal, the current arriving at A will divide, one part passing round the galvanometer in the direction A*c*BGD, and the other in the direction A*b*DGB, and these currents being equal and

opposite will balance each other, and therefore produce no deflection of the galvanometer needle. If, however, the resistances a and b are different, then the tensions at B

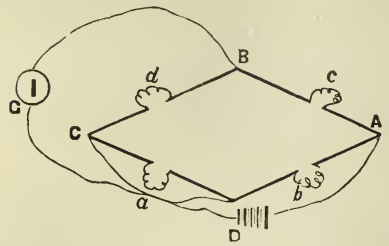


FIG. 91.

and D being also different, a current will pass through the galvanometer, and the needle will be deflected, the current passing either from B to D, or D to B, according as the resistance a or b is the greater. We can, however, restore the equilibrium of the galvanometer needle by varying one of the resistances until the currents are again equal, and in this way, by noting the lengths say of b and c, we may determine their relative resistances. Further than this, however, we may prove that no deflection of the galvanometer needle takes place when the four resistances are in the proportion $a : b = d : c$. By this we are enabled to obtain the value of the resistance of any conductor placed in one of the breaks—for instance C.

ALGEBRA.

VIII.

EQUATIONS (*continued*).

SOLVE the following equations :

1. $x+3=7$. Ans. $x=4$.
2. $x-a+b=c-d$. Ans. $x=a-b+c-d$.
3. $3x-5=2x+9$. Ans. $x=14$.
4. $2x+3=x+17$. Ans. $x=14$.
5. $5x-4=4x+25$. Ans. $x=29$.
6. $4y-10+4=3y$. Ans. $y=6$.
7. $y-10-b=6-b$. Ans. $y=16$.
8. $a-b-y=d$. Ans. $y=a-b-d$.
9. $7x=28$. Ans. $x=4$.
10. $6x=20-4x$. Ans. $x=2$.
11. $12x+20=6x+44$. Ans. $x=4$.
12. $ax=ab-ac$. Ans. $x=b-c$.
13. $\frac{x}{8}=32$. Ans. $x=256$.
14. $\frac{2x}{3}+4=\frac{7x}{12}+9$. Ans. $x=60$.
15. $\frac{5x}{6}-9=\frac{10x}{11}-19$. Ans. $x=132$.
16. $\frac{x}{4}+\frac{x}{6}-\frac{x}{10}=\frac{57}{4}$. Ans. $x=45$.
17. $\frac{3x}{a}-c+\frac{x}{b}=4x-\frac{2x}{d}$.
Ans. $x=\frac{abcd}{3bd+ad-4abd-2ab}$.
18. $5-\frac{y+4}{11}=y-3$. Ans. $y=7$.
19. $3x-\frac{a}{b}+cx=\frac{a+x}{3}-\frac{b-x}{a}$.
Ans. $x=\frac{a^2b-3a^2+3b^2}{8ab+3abc-3b}$.
20. $\frac{ax}{b}=d+c$. Ans. $x=\frac{bd+bc}{a}$.
21. $\frac{y+1}{2}+\frac{y+2}{3}=16-\frac{y+3}{4}$. Ans. $y=13$.
22. $\frac{42x}{x-2}=\frac{35x}{x-3}$. Ans. $x=8$.
23. $\frac{128}{3x-4}=\frac{216}{5x-6}$. Ans. $x=12$.
24. $3x+2a=2a+b$. Ans. $x=\frac{1}{3}b$.
25. $7x-18=4x+6$. Ans. $x=8$.
26. $5x^2-12x=9x+2x^2$. Ans. $x=7$.
27. $\frac{x-5}{3}+\frac{x}{2}=12-\frac{x-10}{3}$. Ans. $x=14\frac{4}{7}$.

The student knows from his arithmetic that in any proportion the product of the extremes is equal to the product of the means. This fact enables us to convert proportions into equations, and equations into proportions. Thus if $a : b :: c : x$, we have the equation $ax=bc$.

Solving this, we find $x=\frac{bc}{a}$.

Examples.

Find x from the following proportions :

1. $x : 31 :: 4 : 6$. Ans. $x=20\frac{2}{3}$.
2. $3x : 16 :: 21 : 112$. Ans. $x=1$.
3. $\frac{1}{6}x : m :: a : n$. Ans. $x=\frac{am}{\frac{1}{6}n}$.
4. $x : 16-x :: 6 : 10$. Ans. $x=6$.

PROBLEMS SOLVED BY SIMPLE EQUATIONS.

Algebraical equations may be used to find the solution of many arithmetical problems. It is difficult to give any general and easily understood rule for doing so; but a few examples will make the following explanations intelligible.

If we examine and think over any arithmetical problem, we find that invariably certain quantities are known (or *given* as we sometimes say), and certain other quantities, not directly given, are stated to be *related* in a particular way to the given quantities, and by means of this relation we are required to find the values of the unknown (or ungiven) quantities.

We must endeavour to express this relation between the given and ungiven quantities in the form of an equation, letting some letter, such as x or y, stand for the ungiven quantity. To take a very simple illustration, find that number which, when 5 is added to its half, gives 15 as the result. Here the ungiven quantity is a number which we may call x, and the given quantities are the two numbers 5 and 15. The relation between them is that half the ungiven number plus 5 make 15. Now:

this is easily put into algebraical language, and it turns into the equation $\frac{x}{2}+5=15$, from which we find $x=20$. Thus the ungiven number must be 20.

Again, let it be required to divide the number 21 into two parts, such that 10 times 1 of them may exceed 9 times the other by 1. We must first consider what we know and what we do not know. In this case, taking the unknowns first, we do not know the two parts of 21. We therefore call one of them x. We might call the other y; and this the student would naturally do. But we must avoid introducing more unknowns than are absolutely necessary; and it is clear that the other part must be $21-x$. Now, we are told something about the relation of these two parts of 21—viz., that if the one of them be multiplied by 10 the product will be greater by 1 than the other multiplied by 9. 10 times the one is $10x$; 9 times the other is $9(21-x)$. To the latter we must add 1 to make it equal to the former; that is—

$$10x=9(21-x)+1.$$

Solving this equation, we have—

$$10x=189-9x+1$$
$$19x=190$$
$$\therefore\ x=10, \text{ one of the parts.}$$

The other part is $21-x$; that is, $21-10$, or 11. And on trial the student will find that these two numbers fulfil the condition stated in the problem.

Let us look at our equation, $10x=9(21-x)+1$. This is the statement, by means of algebraic symbols, of the relation between the known and unknown quantities. This relation was given us in ordinary language, and we have translated it into algebraic language. If our translation is correct, it must give us an equation from which the answer can be found. Observe that there are two expressions—viz., $10x$ and $9(21-x)+1$, and that by the conditions of the question these two expressions *must* be numerically equal. The whole difficulty in solving problems by equations is to find from the conditions of the question two algebraic expressions which must be numerically equal to each other.

The student must make up his mind clearly as to what he will make x to stand for, and be careful that it stand only for the one thing. The following example is a type of many that are likely to cause him some difficulty at first.

A cistern is being filled by two taps. It could be filled by one alone in 4 hours, by the other alone in 10 hours. How long will both together take to fill it?

Now, it will not be sufficient to say, let x be the time required. Everything must be definitely stated. If we are dealing, as in this case, with time, we must state whether we mean minutes, hours, days, etc. If we are dealing with distance, we must mention whether we mean feet, yards, or miles.

Let x = number of hours required.

The first tap can fill the cistern in 4 hours, $\therefore$ in one hour it can fill $\frac{1}{4}$th of the cistern. In x hours it can fill $\frac{x}{4}$ths. Similarly, in x hours the other tap can fill $\frac{x}{10}$ths. So that the two taps working *together* for x hours will fill $\frac{x}{4}$ths $+\frac{x}{10}$ths of the cistern. But the problem tells us that the cistern is *filled* completely by the two in x hours. Hence $\frac{x}{4}$ths $+\frac{x}{10}$ths of the cistern = whole cistern, or $\frac{x}{4}+\frac{x}{10}=1$.

Clearing of fractions—

$$5x+2x=20$$
$$\text{or } 7x=20$$
$$\therefore\ x=\tfrac{20}{7}, \text{ or 2 hours and } \tfrac{6}{7}\text{ths of an hr.}$$

The student is advised to read and ponder over the preceding illustrations and explanations every time he sits down to work out any of the following examples—and even to read them over *after* he has successfully solved a problem—until their full significance is grasped. He will then find little difficulty in the following examples:

1. Find the number whose fourth part exceeds its fifth by 2. Ans. 40.
2. Find the number to which, when its fourth part and seventh part are added, the result is 39. Ans. 28.
3. Find two numbers whose sum is 60 and difference 10. Ans. 25 and 35.
4. A possesses four times as much property as as B; and their fortunes together amount to £10,000. What is the property of each? Ans. £2,000 and £8,000.
5. At an election, in which there were two candidates, 1071 votes were recorded. The successful candidate had a majority of 147. Required the votes for each. Ans. 462 and 609.
6. A gentleman wishing to relieve a number of beggars finds that, if he gives them 6*d.* each, he will have 20*d.* left; but that he has not enough by 14*d.* to allow of his giving them 8*d.* Required the number of beggars, and the amount of money he has. Ans. 17 beggars; 10*s.* 2*d.*
7. Three persons, A, B, C, are possessed of certain sums of money. A and B together have £120; A and C together have £140; B and C together have £150. What has each? Ans. A has £55; B, £65; C, £85.
8. A father's age is triple that of his son. At the end of 10 years it will be only double. What is the age of each? Ans. 30 and 10.
9. A and B play for a stake of 12*s.* If A win he will have thrice as much as B; but if he lose he will have only twice as much. How much has each? Ans. 20*4s.* and 8*4s.*
10. Four merchants entered into a speculation, for which they subscribed £4755. Of this sum B paid three times as much as A; C paid as much as A and B together; D paid as much as B and C. What did each pay? Ans. £317, £951, £1268, and £2219.

ZOOLOGY.

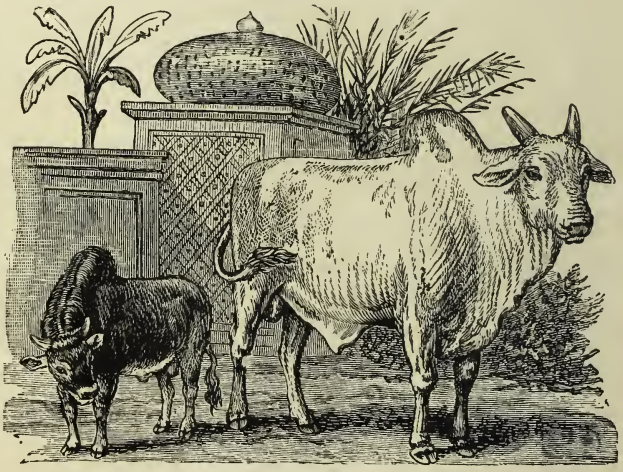
XXXIII.

RUMINANTS (*continued*).

THE horns of the Giraffe or Camelopard are strikingly different from those of the foregoing, for they are covered permanently by skin, not horn; they are really distinct bony growths, not merely outgrowths from the frontal bones, and are situated further back than those of the hollow-horned ruminants. There is a less prominent single bony growth in the middle of the nasal region.

The giraffe.

The male giraffe attains the great height of sixteen feet, the female being somewhat shorter; a considerable portion of this elevation belongs to the neck, which, however, only includes seven vertebræ, forming a not very graceful combination. They extend from near the Cape to Nubia on the eastern side of Africa and to Senegal on the west. They move very rapidly when pursued, and are much hunted; but they have little power of self-defence. Their food is derived from the lower branches of trees, whose leaves they gather with their flexible tongues.



DWARF ZEBU. BRAHMIN BULL OR ZEBU.

The horns of the Deer tribe, occurring usually in the males only, are solid bony growths from the frontal bones of the skull, at first covered by a soft skin, or "velvet," which ultimately dies, and is worn away. Some little distance above the base, a ridge becomes marked, at which all growth ceases in the skin after the horn or "antler" is fully developed. This formation can take place with surprising rapidity, 72 lb. weight having been known to have grown in ten weeks.

Deer horns.

In the latter part of each season the antlers separate at the scar or ridge, and in winter its base is again covered with skin marked by a scar. In each year, in many kinds of deer, the antlers become more elaborately branched; those of the red deer being of the most complex type, reaching in adult age to as many as sixty points in Continental forests.

The Elk or Moose Deer of the northern cold regions of America, Europe, and Asia, is the largest member of the family. Numerous species of deer occur all over Europe, Asia, the larger islands, Africa, north of the Sahara, (the Barbary deer), and America—being, however, few in South America. Among them the red and fallow deer, the roebuck, and the axis deer of India are noted.

The Reindeer, however, is the most useful and interesting of all the deer, in the sense of being essential to a considerable portion of the human race. In all the northern arctic regions it is abundant; extending in North America, under the name of Caribou, down to Canada. Both sexes have antlers, those of the female being less complex. The reindeer is strongly made, and is especially adapted for travelling over snow by the extent of the fissure between the two hoofs, enabling them to be spread out in treading. Thus the reindeer is of the greatest possible value to the Laplanders as a beast of draught; and the facility with which it discovers its special food, a kind of lichen, when deeply buried under the snow, by its remarkable sense of smell, makes it doubly valuable. Not only does the flesh serve for food, but the skin is used for clothing and tents, and the bones and antlers are employed by the Laplanders for fashioning many household utensils.

Reindeer.

Usefulness.

The Camels and Llamas form a distinct group of ruminants, characterised by a flat foot with rather small nails instead of hoofs, and a thick skin pad below the bones of the two digits. Their necks are long, but not proportionately so long as that of the giraffe. Their teeth include a single upper incisor on each side; and one canine is found on each side above and below. The stomach has two long groups of "water-cells" connected with the paunch by somewhat narrow mouths. In these, the water drunk by the animal is accumulated, and reserved for gradual use during prolonged journeys or droughts. The camels are distinguished from their smaller South American allies, the llamas, by possessing one or two humps on the back; these are masses of fat stored up in firm connective tissue; they diminish after prolonged fasting or very heavy labour.

Camels and llamas.

Water-cells.

Camels' humps.

The camel is not now known in the wild state; as a domestic animal it extends from North Africa to China. The typical camel of Arabia is one-humped, and there are two varieties, one the dromedary, attaining a great pace, another being the more useful for carrying burdens. The camel is not docile and attached to man in the same way as the horse; and sometimes is stupidly savage. The Bactrian or two-humped camel has a thicker coat, and is found to the north and east of the Arabian form.

The dromedary.

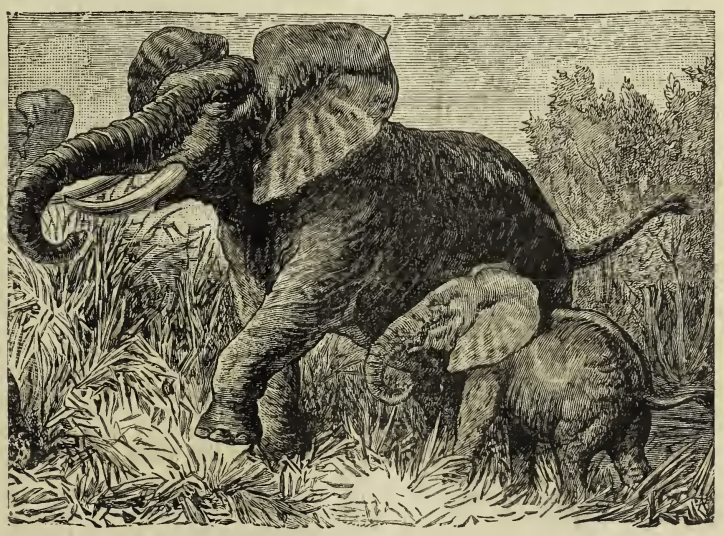
The llamas of the mountains of temperate South America are valuable to the inhabitants for their long wool, their skins and their flesh; they are easily distinguishable from sheep by their length of neck. Like the camels, they can endure considerable privation of water. The alpaca is a domestic form of the vicuna, a small species of llama; the weaving of its fine and long wool

Alpaca.

acting hose of seven feet long, the elephant can, if so moved, absorb a considerable quantity of water for the drenching of an enemy; can pick up the minutest object; can drag up a small tree by the roots, or pull down a large branch; can supply its huge mouth with food and water. In fact, without it the elephant would be destitute, for its short thick neck would prevent the mouth from gaining its food.

The two living species, the Indian and the African, are well distinguished by their teeth. The upper incisors grow out into an enormous pair of tusks, forming the most valuable ivory; but in the Indian female these tusks are absent. There are no incisors in the lower jaw. No canines are present. The great grinders, of which only two appear above the gum at one time on each side, (others, to the number of six in all, being kept in reserve,) present a most complex pattern, as if they were built up of a number

The tusks.



ELEPHANT.

by Sir Titus Salt, in 1836, was the commencement of the very extensive manufacture of alpaca as a fabric.

ELEPHANTS.

Although the elephant was formerly grouped with the rhinoceros and hippopotamus among the thick-skinned or pachydermatous order, yet modern science decides that by its remarkable teeth, and its trunk, combined with other characters, we are compelled to place the elephant apart from all other quadrupeds in an order of its own. The trunk is really only a very long nose, containing two channels divided by a partition; but its extraordinary supply of muscles and nerves makes it serve as a delicate and flexible hand; and the upper projection at the entrance of the trunk meeting the lower, gives it all the powers of an opposable thumb. With this flexible self-

The elephant's trunk.

of large narrow teeth flattened against one another; but these are only so many flat outgrowths formed by the pulp of a single tooth, the mass of each plate being converted into dentine, this surrounded by hard enamel, and this again by tooth bone, or cement. These three substances being of unequal hardness, the transverse ridges of hard enamel stand out markedly above the other softer materials, which are worn down more rapidly. We cannot easily imagine a more efficient grinding apparatus than that afforded by a pair of these teeth working upon one another. The pattern of the teeth of the African species is distinguished by fewer plates, never exceeding ten, which are broader than in the Indian; while the last lower grinder in the latter may have as many as twenty-seven plates.

The grinding teeth.

Ridges.

The enormous size of the skull is not an indication of the bulk of the brain, which is little

larger than man's, although it is well convoluted.

Huge skull. Of course the sockets for the teeth occupy a large space, but beyond this there is an immense development of the bony substance of the skull—not in a solid form, however, but as hollow spaces divided by thin walls of bone, an exaggeration of that hollowing which is found in our own frontal bones. No doubt this increased size is a protection against many dangers which the elephant must encounter in its progress through forests.

The elephant possesses five toes, encased in small hoofs, upon each foot, and walks upon the

Feet and legs. apex of all; but its weight is principally supported by a thick firm pad beneath the principal bones of the foot. The legs are singularly straight, and the fore-legs longer than the hinder; the thigh-bone is the longest among existing quadrupeds, and the straightest Among other external characters we may note the large lobe of the ear, which

Ear-flap. becomes huge in the African species, even meeting over the top of the neck. The thick skin has scarcely any hair.

The stomach is simple, distinguishing it from that of the ruminants. The food which the

Stomach. great creature supplies it with includes very varied vegetable substances: many kinds of fruits, especially of palms; tender shoots of trees and shrubs; indeed, a marvellous amount of destruction is often accomplished by them, for many of the

Food. trees whose leaves they enjoy bear leaves only at a considerable height, and the tree must needs be uprooted before the coveted green meat can be attained.

Were it not that man finds the elephant docile and helpful as a bearer of burdens, and

Utility. as an auxiliary in war and hunting, there can be little doubt that he would soon become extinct; for the area of his unrestricted roaming would certainly be diminished to a great extent, since the crops of civilised communities suffer too severely from tramplings by these "heavy-weights."

The height of the elephant, in cases which are thoroughly attested, does not exceed twelve

Height and age. or thirteen feet, and is seldom beyond ten. His age may certainly extend beyond a century, for some have been kept in confinement for that period; it does not appear possible that any teeth should remain fit for grinding after a longer period than this, although it has been believed that several centuries of life may sometimes be attained.

The use made of elephants in war dates from an early period. Ivory (no doubt from

Long use in war. elephants), was brought to Jerusalem for Solomon. The training of elephants is described in the first book of the Maccabees, and the "towers of wood" fastened upon them. The efficient introduction of the elephant by Pyrrhus into his wars with the Romans is well known, as also the transit of the Alps by Hannibal with thirty-seven elephants. Covered with gorgeous trappings, the elephant has equally subserved the stately displays of oriental rulers. Its intelligence, too, is well attested.

IX.

Causes of Varying Expression (*continued*).

There are more extensive changes in the skin than we have already mentioned, which modify expression materially. Firmness is conspicuously wanting in the textures of the child, and evidently present in those of the adult, combined with great elasticity in delicate and refined women. In the adult there is a development and activity of the minute muscular

Muscular fibres of skin. fibres of the skin itself, in addition to the muscles beneath the skin. When these minute fibres are in action they produce very varied alterations in the surface of the skin, causing it to present variations in undulation, in roughness and smoothness. These changes are produced in correspondence with varied emotions, and also in relation to the different diseased conditions of the body. A very relaxed and flabby condition of the skin is associated with many weakening diseases. A contraction and tenseness, with increased redness, is found in various states of fever.

The most salient changes in facial expression and in the tissues producing it take place about the period of puberty. Their most marked demonstration

The beard. consists in the appearance of the beard. At the same time the papillæ of the skin enlarge, the sweat-glands and the sebaceous follicles become more extensive and active, and the hair-follicles deepen and enlarge, giving forth a stronger growth of that clothing which characterises the whole skin of man more or less.

The beard is a most important agent in expression. It is developed, often very much in keeping with the cut of the face, and if it is less so in some

Its importance in expression. cases it is due to the great artificial cultivation it has undergone by continual shearing, giving a bristle-like character to that which is naturally very flexible.

Those who maintain their face always closely shaven lose more than they imagine of a characteristic expression. A man's beard naturally assumes a style

Close shaving. which belongs to him and suits him, just as his hair does. Many who claim that they have an artistic appreciation of the whole structure of man, assert that the close shaven man really looks unnatural and deformed, quite as much as if he wore his scalp devoid of hair. What is more than anything a part of our conception of the dignified appearance of an old man? Undoubtedly it is

Dignity of old man's beard. his long beard, which is then often in its most luxuriant growth.

The upper lip usually exhibits a much more profuse growth of hair than the under lip, and

it is of a darker colour. It tends to diverge from the middle line and to be longer at the angles of the mouth than nearer the centre. Again, the chin, although its covering may be tufted and thick in some cases while there is little hair on the cheeks, most frequently has the whiskers shorter than those borne by the sides of the face.

Moustache.

Hair on chin.

The very temperament of a man is more or less indicated by his beard. A coarse beard most often is found associated with a coarse nature, a fine one with a refined. When there is much emotional excitability, causing great play of the skin in expression, the whiskers are moved proportionally, and the effect is heightened. As the upper lip and nostrils play in excited respiration, so the moustache is moved with them.

Coarse and fine beard.

The whiskers have a still further influence on expression from the very structure of the hair-bulbs. The minute muscular fibres attached to these are capable of separate contraction, and so raise or depress the hair in sympathy with the emotions. When we say a man "bristles up," the beard being erected in this way partially produces the effect upon our minds.

Action of hair muscles.

"Bristling."

In old age again the grey or white appearance of the beard and hair is gradually assumed by reason of the blanching of the pigment of the hairs. What is the precise method of producing this effect is not at all known. The whiskers frequently at this period become much longer and stronger, while at the same time the hair of the scalp grows thinner and weaker, often falling off altogether. The whiskers usually get grey before the hair, and it is a gradual process, commencing at the tips of the hairs. The moustache mostly remains unblanched longest.

Grey and white hair.

We have all heard of cases in which the hair has been described as turning grey in a single night; but very few such cases have been scientifically investigated. There seems to be no direct evidence of such sudden and complete change as is commonly supposed. No doubt anxiety and fright do affect the colour of the hair, and may produce an alteration at any age. There may be a very perceptible difference in a single night, but a radical transformation is a work of time.

Hair turning grey rapidly.

We notice a gradual change in the colour of hair in young persons. Frequently they are born with hair almost white, or of a very light yellow; but as they grow up, very frequently there is a darkening of the pigment in the successive growths of the hair until it may assume a very decided brown tint. It does not appear that the perfectly black pigment is produced by this process of transformation. The reverse process, a lightening of the colour in approaching adult age, may sometimes be observed.

Changes in colour of hair in youth.

Similarly the whiskers at their first appearance may be lighter in colour than they afterwards are. Thus there is a real transition between the light colour of most of the minute hairs clothing the body and the more pronounced hues of the beard. There is a general agreement between the tints of the hair and the beard, but sometimes there is a decided difference. Generally speaking, the whiskers have a more pronounced and stronger tone about them, the hair affecting hues of a more neutral character.

The Bony Skull.

The great mass of the skull is constituted by the brain-case; it also has cavities for the protection of the organs of the special senses. On the face it encloses the teeth, and one conspicuously-movable bone, the *lower jaw*. Another bone, the hyoid or U-shaped bone, which is only attached by means of fibrous cords to the rest of the skull, must yet be included in its description. The bones are but slightly furnished with ridges for giving support to muscles.

Skull: including brain-case, cavities for sense-organs, and jaws.

In shape the brain-case is an elongated spheroid, with compressed sides, and it is supported near the middle of its base upon the vertebral column. This support, so far as bones take part in it, is in the situation of two oval smooth surfaces, the *occipital condyles* which are placed obliquely, closer together in front than behind. They rest and move upon the pitted and corresponding upper surface of the topmost bone of the spinal column, the *Atlas* vertebra*. Thus the great hole, or foramen magnum, † has wonderfully strong boundaries, such as we might imagine to be necessary to protect the spinal cord from injury as it is continued upwards to join the brain.

Vertebral column.

The skull is made up of many bones, separated in very early life, but interlocked at a later period by tooth-like processes or *sutures*. These bones are of varied shape and size, some being flat, others cubical, others extremely irregular. It will be best to speak of the separate bones before studying the general aspect of the skull. The bones may be roughly divided into those which belong to the *brain-case* and the *face*.

Many bones united by sutures.

The Bones of the Brain-Case.

We will first notice the bones which compose the roof of the brain-case. In front there is the *frontal*,‡ forming the entire expanse of the forehead between the temples, extending upwards almost to the most elevated part of the head, and having besides two thin horizontal plates which form part of the roof of the orbit, or cavity for the eyeballs. It bears the prominent

The roof-bones.

* So called from Atlas, the fabled supporter of the whole world. The human head is the most important thing in the world, and thus the Atlas vertebra resembles Atlas in its functions.

† Latin *foramen*, a hole, or perforation; *magnum*, great.

‡ Lat. *frons, frontis*, the face, brow.

superciliary ridge, and projects over the upper part of the nasal cavities. The inner surface is a large concavity overlying the front of the brain.

Behind the frontal we find a pair of *parietal** bones, forming a great part of the roof and sides of the skull. They are strongly arched, convex outwards and concave inwards, and they are not of a complicated structure.

Parietal bones.

The hinder part of the brain-case is occupied by the *occipital* bone, which also stretches downwards to the base of the skull, and bears the occipital condyles. The occipital is of an irregular lozenge shape, with strong transverse semicircular ridges behind, for attaching the muscles which balance the head upon the spine. At the base, beyond the foramen magnum, or great communicating hole between the brain-case and the spinal canal, it becomes thick and massive, forming the *basilar* or basal process; laterally it juts out to form a union with the bone containing the internal organ of hearing. In early life the occipital is made up of four distinct bones.

Occipital bones.

Basilar process.

Continuing forwards from the occipital bone along the base of the skull, we meet with the remarkable *sphenoid*† bone, which is wedged in between the lower parts of the frontals and occipitals, and sends out snags of bone in many directions. It is thick and massive in the middle, although having a deep pit in its upper surface.

Sphenoid.

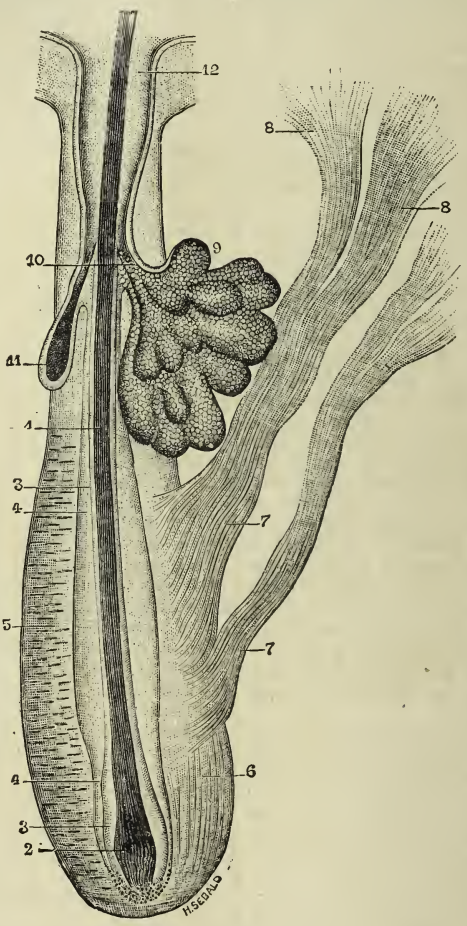


FIG. 18.—HAIR IN ITS FOLLICLE, SEBACEOUS GLANDS, AND MUSCLE, FROM THE SCALP.

1, 2, 3, 4, 5, 6, Hair and its follicle. 7, 8, Muscles, *erectores pilorum*. 9, 10, 11, Sebaceous glands. 12, Opening of hair follicle and duct for sebaceous glands.

On either side, the sphenoid sends out wide processes of bone called the greater wings, which are concave upwards. These stretch to the parietals, and assist in supporting the brain. The wings are thickened towards the front and have a flat surface, which forms part of the outer wall of the orbit, while another portion behind curves out on the surface of the skull, beneath the zygoma or yoke-bone.

Greater wings of sphenoid.

Then there are smaller wings which arch over the exit of the optic nerves from the skull; and also processes which extend downwards on either side behind the lower jaw. From these latter processes, called *pterygoid*,* the strong pterygoid muscles which pull upon the back of the lower jaw, and perform a very important part in mastication, derive their support. The interest of the sphenoid bone to the anatomist may be seen from the fact that it is tied by suture to every other bone of the brain-case, and to five of those of the face. It really corresponds to a great many bones which are found separate in lower animals, and before birth in mankind.

Lesser wings of sphenoid.

Pterygoid processes.

The *temporal*† bones are of scarcely less interest, for they contain the intricate structures of the organ of hearing. One of its principal regions is wedged in on either side between the sphenoid and the occipital bones, and is called *petrous* from its hard massive structure; it is this portion which contains the labyrinth of the ear. There is another flat region, the *squamous*,‡ which extends upwards into the side of the skull below the parietal, and overlaps it by a thin edge. Finally, there is a mass of bone below and behind the others which forms a prominence behind the ear and gives attachment to muscles: it is the *mastoid* or nipple-like part. The opening of the bony canal leading into the internal ear is just at the junction of the mastoid with the squamous portion of the bone. Then immediately in front of this is a hollow with a smooth surface, in which the condyle of the jaw fits and works;

Temporal bones.

Petrous, squamous, and mastoid parts.

* Lat. *parĭes, parietis*, a wall.
† Lat. *sphēn*, a wedge.

* Greek, *pteryx, pterygos*, a wing.
† Lat. *tempora*, the temples.
‡ Lat. *squama*, a scale.

it is the glenoid pit. There is a prominence of bone in front, which prevents the jaw from slipping out forwards.

Glenoid surface.

From just above this pit there passes forwards a rod-like piece of bone, which is the external buttress of the face, a connecting-rod between the outer side of the temporal and the *malar* or lateral cheek-bone. This yoke-bone, or *zygoma*,* protects the anterior process of the lower jaw to which the powerful temporal muscle is attached.

Zygoma.

The under surface of the petrous portion is of high interest, from the holes it contains, especially that opening by which the internal carotid artery enters the skull. This corresponds with a spot just in front of the *mastoid* process, but nearly an inch beneath the skin. The carotid canal has a sinuous course in the bone, and opens in the brain-case in the front edge of the petrous bone.

One of the most remarkable nerves, the facial, penetrates this bone and emerges within and in front of the mastoid process. Near this again there projects a long and nearly straight splinter of bone, the *styloid*† process, an inch long, plunging down into the neck and giving attachment to important muscles.

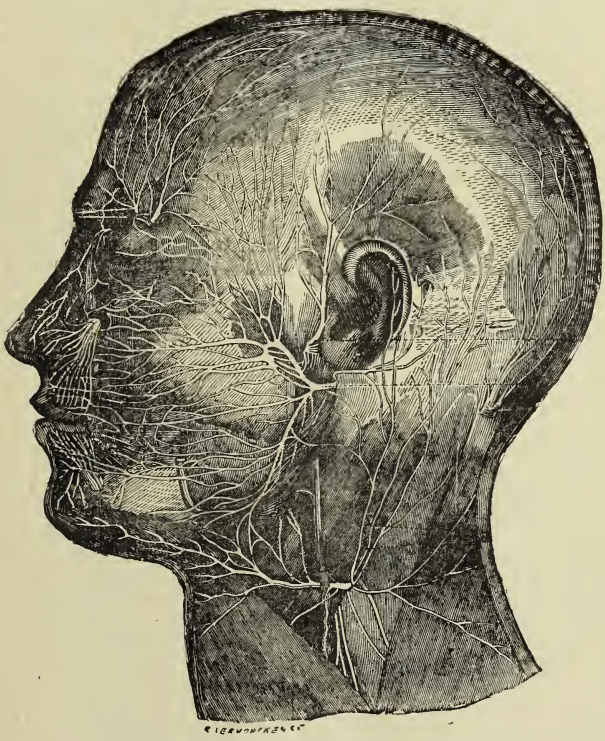


FIG. 19.—DISSECTION SHOWING THE DISTRIBUTION OF FACIAL AND OTHER NERVES.

The tale is not yet complete; for we must speak of the strong ridge formed by the petrous bone inside the skull, a vein resting on it, and of the opening on this surface by which the auditory nerve, as well as the facial, enters the bone. It will readily be understood how dangerous to life a fracture of these bones at the base of the skull is. In them are excavated tunnels, through which pass most important messages by the nerves, and currents of blood by the arteries and veins, as well as secret recesses for the delicate organs of hearing.

* *Zygoma*, from Greek *zygon*, a yoke.
† *Stylon*, a small pointed rod.

KEY TO FRENCH EXERCISES.—IX.

EXERCISE XLVII. (*page* 623).

1. Le chef d'orchestre appelle les premiers violons autour de lui. Il les appellera longtemps; ils sont en grève. 2. La sonnette rappelle les musiciens à l'orchestre. 3. Les cloches ne nous appelaient-elles pas à l'église? 4. Elle appela le tambour à voix basse, et lui répéta les paroles du clairon. 5. Le corniste soufflettera la clarinette, parce que celle-ci l'a appelé corneur. 6. Le guitariste épelait péniblement sa partie, et le harpiste feuilletait un cahier de musique. 7. Emmuselez donc votre chien; le voisin va jouer du trombone. 8. Le cornemuseur renouvelait ses efforts; comme ce cornemuseur halette! il n'en peut plus. 9. Ce violoniste rejettera-t-il toutes les offres du régisseur? 10. M. X., le violoncelliste, projette-t-il de donner un concert? En effet; il m'a parlé d'une matinée qu'il a l'intention d'organiser. 11. Le pianiste furette partout; il a égaré ses lunettes; le chef d'attaque des altos les lui montre. 12. Il faudra que les flûtistes répètent leur partie; ils ne la possèdent pas encore. Il ne faut pas que le bassiste répète la sienne à haute voix. 13. M. Z. joue-t-il bien du hautbois? Il n'en joue pas mal; il en jouerait mieux s'il possédait le sentiment du rhythme. 14. Tiens, voici une harpe. Qui est ce qui en joue?—Mlle B. En joue-t-elle bien?—Elle en jouera dans la soirée; vous jugerez (*or* vous pourrez en juger). 15. Malheureux, qu'est-ce qui vous pousse à jouer de l'accordéon? Jouez

plutôt du mirliton, de la guimbarde, ou de n'importe quoi. 16. Menez le vielleur à la cuisine pour qu'il s'y rafraîchisse : portez-lui sa vielle ; il n'en peut plus. 17. Si nous ramenons le hautbois au buffet, il y rapportera sa soif ; emmenons-le plutôt au vestiaire. 18. Amenez-nous ce fameux virtuose, et priez-le d'apporter son instrument avec lui, pour qu'il nous en joue. 19. Remmenez la grosse caisse à la caserne et emmenez le timbalier avec vous. 20. Puisque vous nous avez amené la fanfare de la ville, vous pouvez aussi la remmener.— Mais les instruments ? — Ceux qui les ont apportés les remporteront, voilà tout.

EXERCISE XLVIII. (*page* 623).

1. Boileau says : "I call a cat a cat, and Rollet a rogue." This is calling things by their name. 2. Turenne's genius had called him to the command of armies ; that celebrated warrior died with his face turned to the enemy. 3. Richelieu, called into the king's councils, soon had his own way. 4. At the moment of putting-to, the coachman gave himself a blow on the head, which caused him to fall backwards. 5. He yoked kings to his triumphal car. 6. The servants must dust my clothes. 7. I have seen the Rhone ; its course is often impetuous. 8. When one is in a country, one must follow its customs. 9. Cheerfulness is the health of the soul, sadness is its poison. 10. Two whole days, casting away his food he panted under a burning sky. 11. Science must be full of consideration for ignorance, which is its elder sister 12. In autumn, trees lose their leaves. 13. Is it his gout which keeps him at home? 14. Cast your eyes to the ground, puny worms that you are. 15. And I (*for my part*) do not think that it is worthy of the people in whom God reflects Himself to join to the arm that kills a hand that slaps (*i.e.* a judge should not insult). 16. The butler wounded his hand in sealing the bottles. 17. As spirits of wine never freeze, one uses the thermometer with alcohol in Siberia. 18. The excessive cold froze his nose. 19. My unarmed fist hammers armours better than a knotty oak picked in the forest. 20. There is no livelier, merrier, madder pen than his.

EXERCISE XLIX. (*page* 624).

1. En appelant un chat un chat, on appelle les choses par leur nom. 2. Louis XIV avait appelé Colbert dans ses conseils ; tout prospérait. 3. Les gens croyaient qu'on pouvait les ensorceler, et l'imagination les ensorcelait effectivement. 4. Le cocher se fit mal au genou en tombant à la renverse. 5. Cérès présentait aux hommes une charrue et faisait atteler des bœufs. 6. La Fontaine est mon auteur favori ; j'aime sa naïveté, sa malice, et son esprit gaulois. 7. Le temps fuit, la perte en est irréparable. 8. La campagne a ses agréments ; les plaisirs en sont sans nombre. 9. L'Amazone est une rivière immense ; tous les voyageurs s'extasient de la fertilité de ses bords. 10. Un feu divin étincelle dans les yeux du jeune guerrier. 11. Elle avait au bout de ses manches une paire de mains si blanches, que je voudrais en vérité en avoir été soufflété. 12. Depuis la veille du dimanche des Rameaux jusqu'à la seconde fête de Pâques, il était permis dans la ville de Béziers de souffleter tous les juifs qu'on rencontrait. 13. Comment les voleurs ont-ils pénétré dans la boutique du facteur ? Par la porte ; après avoir crocheté la serrure. 14. Je lui ai sali la main avec de l'encre. Elle avait sali mon mouchoir avec de l'encre. 15. Est-ce sa migraine qui la retient chez elle comme de coutume ? 16. Je ne vous ai jamais vu ainsi ; que vous manque-t-il ?— J'ai mal à la tête. 17. Prenez garde, vous allez vous brûler les doigts avec cette cire à cacheter. 18. Le froid excessif leur a gelé les pieds. 19. Ils amoncellent les gerbes ; ils les amoncelèrent ; les amoncelleront-ils ? ne les amoncelleraient-ils pas ? 20. Il n'y a jamais eu au ministère des affaires étrangères de meilleure tête que lui.

EXERCISE L. (*page* 690).

1. Lampreys were preferred by the gluttons of Rome to any other fish. They were reared in large ponds, which were not intended for them alone. Such was the fish-pond constructed by C. Hirtius on the sea-shore, and of which the most part of the lampreys were devoured at the feasts offered to the Romans on the occasion of Julius Cæsar's triumphs. 2. At that time Scotch servants used to stipulate that salmon should be served only once a week in the servants' hall. 3. Young turbots are more valued than big turbots, because they are more delicate. 4. Those turbots have been done with a white sauce, or with oil. 5. The carps reared in ponds are less sought after ; they contract a mud flavour. 6. A young carp, which was nothing better than fry, was caught by a fisher on the bank of a river. 7. Almost all fishes, but especially soles, whitings, flounders, dabs, smelts, carps, tenches, barbels, gudgeons, and all small white fish, may be fried. 8. This pike *matelote* would be appreciated at a king's table.—What is a *matelote* ? This dish is made up of fish dressed with wine and onions. 9. Rock lobsters are a much esteemed food, particularly along the coasts of the Mediterranean. The eggs are also much sought after, and the females provided with them sell four times dearer than those which have none. 10. Fish which has been dried in the sun is known in trade under the name of stockfish.

EXERCISE LI. (*page* 691).

1. A Hambourg, les lamproies sont salées ; à Dantzig, elles sont fumées. Sous ces divers états elles sont expédiées dans les contrées les plus éloignées, où elles sont servies sur les meilleures tables. La ville de Gloucester est dans l'usage de faire présent chaque année au souverain d'un pâté de lamproies. Worcester aussi est célèbre pour ses pâtés et ses conserves de lamproies. 2. Les huîtres pêchées en mer seront engraissées dans les parcs. Les huîtres vertes étaient alors fort recherchées. 3. Vos moules sont-elles toutes vendues ? 4. La sauce aux moules est plus estimée par quelques gourmets que la sauce aux huîtres. 5. Les moules ne doivent pas être mangées crues. 6. Ces deux personnes ont été jetées dans le même

moule. 7. Une raie au beurre noir doit être servie aussi chaude que possible. 8. Comment ces soles ont-elles été accommodées?—Elles sont accommodées au gratin. Et vos éperlans? —ils sont frits. Et les anguilles?—elles sont panées, et seront servies avec une sauce à la tartare. 9. A l'exception du saumon et de la truite, les poissons d'eau douce ne sont pas fort estimés en Ecosse. Les lamproies et les anguilles y sont abhorrées. 10. Les escargots, recueillis sur les feuilles de vigne, ont été saupoudrés, enlevés de leurs coquilles, lavées à grande eau, puis ils ont été remis avec du beurre et de fines herbes dans les coquilles, et enfin rôtis au four. 11. Ce thon sera-t-il mariné ou sèché au soleil? Il sera salé et fumé. 12. Comment voulez-vous qu'on accommode les harengs?—Je les voudrais à la maître d'hôtel; ou peut-être grillés à la sauce blanche aux câpres; frites; au gratin ou au beurre noir. 13. Etre serré comme des harengs dans une caque. 14. Le poisson d'eau de mer frais, qui n'est pas salé, est connu en français sous le nom de marée. 15. A Paris, le poisson de mer frais, après avoir été visité par le commissaire des Halles, est mis en vente à quatre heures ou à cinq heures du matin, selon les saisons.

EXERCISE LII. (*page* 691).

1. Mon maître vous prie d'accepter cette cloyère d'huîtres. 2. Qu'attendez-vous?—J'attends le convoi de marée. 3. Nous cherchions de petites truites sous les pierres. 4. Que pourriez-vous désirer de plus? Je pourrais désirer un potage à la bisque, ou une bouillabaisse. 5. Voulez-vous que je cherche la truelle à poisson?—Oui, cherchez-la. 6. Voulez-vous permettre à mon fils cadet de pêcher dans vos étangs?—De bon cœur, si c'est pour la pêche à la ligne. 7. Mon intendant répondra à toutes les demandes d'autorisation de pêche. 8. Il est expressément défendu de pêcher à l'épervier. 9. Quand nous allons à la pêche, nous obéissons toujours aux règlements. 10. Papa, où sont mes articles de pêche? Cherche-les, mon garçon. 11. Si vous commandez au batelier de s'arrêter près du trou, nous ne nous en retournerons pas à vide (*or* pas bredouille). 12. Le brochet ne résiste pas à cet appât. Le saumon y résisterait-il? Naturellement. 13. L'ombre-chevalier ne ressemble-t-il pas un peu à la truite? Il y ressemble, seulement l'ombre-chevalier a des couleurs plus vives et possède un goût plus fin. 14. Ces langoustes ne conviendront pas à ma maîtresse. Lui conviendront-elles si je les fais deux francs meilleur marché? 15. Comme ces vairons semblent jouir de la vie! 16. Comme les carpillons jouissent de leur liberté depuis qu'ils ont été transférés des fossés du château dans la rivière. 17. On raconte que les carpes de Fontainebleau datent du règne de François I. A d'autres! Si vous doutez du fait, informez-vous-en. 18. Ne couvrez donc pas le bocal; si vos poissons rouges manquent d'air, ils manquent de tout.

EXERCISE LIII. (*page* 763).

1. Il s'écrie; ils s'écriaient; nous nous écriâmes. 2. Marie, tu t'écrias; mesdames, vous vous écriâtes; il faut qu'elle s'écrie; il faut qu'ils se soient écriés. 3. Elle ne se punit pas; ces religieuses ne s'étaient pas punies. 4. Il ne faut pas que tu te punisses; il ne fallait pas que tu te punisses. 5. M'aperçois-je? t'apercevais-tu? nous apercevrons-nous? 6. Vous en apercevriez-vous? m'en suis-je aperçu? s'en sera-t-elle aperçue? 7. Ne se rendent-ils pas? Ne se sont-ils pas rendus? 8. Ne nous y rendons-nous pas? ne nous sommes-nous pas rendus à Londres? 9. Elle s'accoude; elle ne se sera pas accoudée. 10. Nous nous accroupissons; nous ne nous accroupissons pas ici. 11. Il s'acheminera vers la ville comme de coutume; ne vous acheminerez-vous pas vers la ville comme de coutume? 12. Les enfants s'agenouillent devant l'évêque; le prêtre s'agenouillait devant l'autel. 13. Il s'arrêta un instant au sommet de la colline; s'y arrêta-t-il longtemps? 14. Ils s'assoupissent paisiblement; quelqu'un qui ne s'assoupit jamais. 15. Les citoyens s'attroupent, et se demandent ce qui amène Régulus de Carthage. 16. Je m'y attends; croyez-vous que je ne m'y attendais pas? 17. Nous nous baignons tous les jours; ils se baignaient tous les deux jours; il faut que vous vous baigniez tous les trois jours. 18. Le cheval se cabra; il venait de découvrir une panthère qui se blottissait dans la fourche d'un arbre. 19. Elle se confesse (*or* elle va à confesse) une fois tous les quinze jours. 20. La muraille s'écroule; les terrassiers essayent de s'échapper; quelque temps s'écoule; une vive inquiétude s'empare de nous.

EXERCISE LIV. (*page* 763).

1. Le potiron se vend au poids. 2. Comment se vendent les asperges! Elles se vendent en bottes. 3. Nos pommes de terre ne se sont pas bien vendues; du reste, rien ne se vendait aujourd'hui. 4. Les petits pois se vendent à bon marché; mais les haricots verts se vendent bien cher. 5. Les artichauts se mangent de plusieurs manières; ils se mangent à la sauce blanche, à la barigoule, à la poivrade, à la provençale. 6. Les choux se mangent avec du lard. 7. Les épinards se mangeront mieux si vous y ajoutez quelques feuilles d'oseille. 8. Votre céleri ne se conservera pas longtemps si vous ne le couvrez pas mieux. 9. Croyez-vous que ces légumes se trouvent au Canada? 10. Les raves ne se conservent pas cet hiver. Elles se conserveront mieux s'il continue à geler. 11. Là se voient des champs entiers d'asperges, de cardes, de salsifis et d'artichauts. 12. Comment s'appelle cette plante (*or* comment cette plante s'appelle-t-elle)? Elle s'appelle de la cive. 13. Les choux-fleurs se servent chauds ou froids, à la sauce blanche, au gratin, ou à la vinaigrette. 14. Aller planter ses choux se dit par métaphore d'un homme qui se retire à la campagne. 15. Ne se guérira-t-il jamais de sa passion pour les truffes? Il ne s'en guérira jamais; il s'en fait servir à tous les repas. 16. Les champignons se préparent de beaucoup de manières. 17. Ne pas connaître la différence entre la laitue (ordinaire) et la romaine ne se pardonne pas. 18. Pendant longtemps on se contentait de recueillir le cresson qui se trouvait à l'état

sauvage. 19. Le cresson de fontaine se propage facilement par graines ou par éclats. 20. Le cresson cru se digère facilement avec les viandes grillées ou rôties. 21. Tout champignon se compose de deux parties, l'une souterraine, l'autre aérienne.

POLITICAL GEOGRAPHY.

XVIII.

AUSTRALIA (*continued*).

THE whole of Australia belongs to Great Britain, and is divided into five colonies, viz. New South Wales, Victoria, Queensland, South Australia, Western Australia.

BOLA BOLA (SOCIETY ISLANDS).

NEW SOUTH WALES is situated in the south-eastern part of the island, having on the north, Queensland; south, Victoria; west, South Australia; and east, the Pacific Ocean. Area, 310,937 square miles; population (1881), 750,000. The mountains here are the Australian Alps, Blue Mountains, Liverpool Range, and New England Range, which lie near the coast, and the seaward declivities and valleys of which are well cultivated, producing European grains and fruits in abundance. In the interior are extensive grassy plains, where immense flocks of sheep (35,400,000) are pastured. The staple product of the colony is wool; the mineral products are gold, silver, copper, lead, tin, mercury, iron, and coal. The government is vested in a governor, appointed by the crown, aided by an executive council and a parliament consisting of a legislative council and assembly. In 1880 the revenue was £4,904,230; expenditure, £5,560,078; public debt, £14,903,919; imports, £13,950,075 (from U. K. £6,536,661); exports, £15,525,138 (to U. K. £7,525,637). There are 850 miles of railway in operation. The capital, Sydney, has a university, observatory, public library, and 222,133 inhabitants.

VICTORIA is situated to the south of New South Wales, of which it formerly formed a part, but it was severed and formed into a separate colony in 1851. Area, 87,893 square miles; population (1881), 858,582. Although one of the youngest, and in point of area the smallest of the colonies, it is, in regard to wealth, population, and commerce, the most important. Its extraordinary progress is owing to its being the principal gold-producing colony. The value of the gold produced since its first discovery in 1851 is estimated at nearly £200,000,000. The country is eminently a pastoral one, and wool is the staple product; but of late years agriculture has made rapid progress, and wheat and oats are largely cultivated. Manufacturing industry has also greatly advanced. A considerable quantity of wine is annually produced. There are 1200 miles of railway in operation. The government is similar to that of New South Wales. In 1880 the revenue was £4,621,282; expenditure, £4,875,029; public debt, £22,060,749; imports, £11,556,894 (from U. K. £5,568,593); exports, £15,954,559 (to U. K. £8,178,044). The capital, Melbourne, is the largest city in Australia, having 282,981 inhabitants, together with a university, museum, public library, etc.

QUEENSLAND comprises the whole of the north-eastern portion of Australia, and was formerly included in New South Wales, but was separated and organized into a distinct colony in 1859. Area 669,520 square miles, and population 226,077; the most populous part is the south-east. Along the coast the land is generally fertile, and much of it is well adapted for the growing of sugar, cotton, indigo, maize, and other crops; but the interior

consists very largely of arid steppes. The staple product is wool, but sugar, timber, preserved meat, and the metals, are also largely exported. Queensland is rich in the metals, especially gold, copper, tin, iron, and mercury. The capital, Brisbane, has 30,955 inhabitants. In 1880, the revenue was £1,612,314 : expenditure, £1,673,695 ; public debt, £12,192,150 ; imports, £3,087,296 ; exports, £3,448,160.

South Australia originally comprised only the southern portion of central Australia, but in 1863, by royal letters patent, the limits of the colony were extended so as to include the whole of the central portion from south to north, so that the name is no longer strictly applicable. The area is 904,133 square miles, and the population 279,865. Much of this territory is still unexplored, but there is reason to believe that the greater part of it is little better than barren sandy waste. The most cultivated portion is the south-eastern, and here the country is essentially agricultural and pastoral. Wheat and other grains are grown, and large flocks of sheep are reared. Breadstuffs and wool are the chief exports ; the vine is also largely cultivated. Copper is the metal chiefly found here. In 1880 the revenue was £2,010,082 ; expenditure, £1,079,426 ; public debt, £9,831,100 ; imports, £5,581,497 ; exports, £5,574,505. The capital is Adelaide, with 37,892 inhabitants.

Western Australia comprises all that portion of the island lying west of 129° E. long. It is 1280 miles in length from south to north, by 800 from east to west, and has an area of 975,824 square miles. Little is known of this territory beyond the line of coast, in the south-western part of which the inhabitants are mostly settled. Population only 30,200. A large portion of the country is covered with valuable timber ; and iron, lead, copper, and zinc ores are found. The chief exports are wool, timber, and lead and copper ore. The capital, Perth, with 7000 inhabitants, is situated on the Swan River, which formerly gave name to the whole territory.

Tasmania, formerly Van Diemen's Land, is an island lying south of Victoria, from which it is separated by Bass Strait. It is triangular in form, measuring about 160 miles each way, and having an area of 26,215 square miles. The surface is highly diversified with mountains, valleys, and plains, and is mostly covered with dense forests. Cradle Mount, the loftiest summit, is 5069 feet above the sea. The principal rivers are the Tamar and Derwent, and there are also a number of lakes. The climate is delightful and highly salubrious, resembling that of the south of England. The soil is generally very fertile, producing abundant crops of wheat, barley, oats, etc. The chief exports are wool, grain, fruits, and timber. In 1880 the total exports were £1,511,931, imports £1,369,223. The chief mineral products are iron, copper, tin, lead, coal. The form of government is the same as that of New South Wales, from which it was separated and formed into a distinct colony in 1825. The capital, Hobart Town, has 21,000 inhabitants.

KING WILLIAM STREET, ADELAIDE, SOUTH AUSTRALIA.

New Zealand, a British colony comprising two principal and a number of smaller islands lying about 1200 miles south-east of Australia, between lat. 34° 20′ and 47° 20′ S., and long. 166° 25′ and 178° 35′ E. The northern island is about 460 miles in length by 70 in breadth, and the southern 880 by 110, the total area being 106,260 square miles. A chain of mountains extends from the middle of the northern island to the southern extremity of the southern, and has as its culminating point Mount Cook, in the latter, 13,200 feet high. The country is well watered by rivers, and there are also numerous lakes. A great part of the surface is covered by extensive forests of pines and other evergreen trees. The climate is mild and salubrious, bearing a considerable resem-

blance to that of England. The chief grain crops are wheat, barley, and oats; and sheep are largely reared, so that wool forms a principal export. The mineral wealth is considerable, including gold, silver, iron, copper, tin, coal. In 1880 the total exports were £6,352,692, imports £6,162,011; public debt £28,583,231, The government resembles that of New South Wales. Population 463,729, besides 42,819 natives. The natives of New Zealand (Maories) are much superior to those of Australia, being tall, well-built, active, and intelligent. The capital, Wellington, has 21,582 inhabitants.

PAPUA or NEW GUINEA, the second in size of the Australasian islands, lies immediately north of Australia, from which it is separated by Torres Strait, between lat. 0° 20′ and 10° 45′ S., and long. 130° 40′ and 150° E. It is about 1300 miles in length from north-west to south-east, by from 20 to 400 in breadth, and has an estimated area of 303,000 square miles. It is apparently traversed throughout its entire length by a lofty range of mountains, rising to the height of more than 13,000 feet. The soil is very fertile, and a large portion of the surface is covered with dense forests; but hitherto it has been little explored, and little is known of its nature or productions.

POLYNESIA is the name given to those islands in the Pacific Ocean which are sometimes included with Australasia under the name of OCEANIA. Of these are the Caroline Islands, Sandwich Islands, Society Islands, Friendly Islands, and others; but they do not require any particular description.

END OF "POLITICAL GEOGRAPHY."

LII.

THE PARTICIPLE.

THE participle expresses the same notion as the verb to which it belongs, but it possesses the form of an adjective, like which it is declined.

1. Active participles govern the case governed by the verb to which they belong—as *Puella sibi placens*, a girl pleasing to herself. Observe, a participle when used as an adjective denoting *disposition* or *capacity for*, governs the genitive case—as *patiens* (adjective) *laborum*, capable of enduring labours; but *patiens* (participle) *labores*, enduring labours.

(2) The Latin verb has no Perfect participle in the active voice, and no Present in the passive voice; having in the active voice only an imperfect and a future, and in the passive only a perfect and the gerundive participle of necessity.

(3) There are, however, some few active verbs, and also many deponent verbs, which have a perfect participle active.

The following is a list of the principal active verbs which have a perfect participle with an active sense:—

audeo, I dare	*ausus*, having dared
gaudeo, I rejoice	*gāvīsus*, having rejoiced, rejoicing
sŏleo, I am wont	*sŏlĭtus*, having been wont
fido (and comp.), I trust	*fisus*, having trusted
jūro, I swear	*jūrātus*, having sworn
cæno, I dine	*cænatus*, having dined
prandeo, I breakfast	*pransus*, having breakfasted
nūbo, I am married	*nupta*, having been married to
ŏdi, I hate	*ōsus*, having hated, hating

Some deponents use their perfect participle both in an active and a passive sense. The following are among the principal ones that do so:—

adĭpiscor, I attain to	*ădĕptus*, having attained, or having been attained
cŏmĭtor, I accompany	*cŏmĭtātus*, etc.
confiteor, I confess	*confessus*, etc.
meteor, I measure	*mensus*, etc.
experior, I try	*expertus*, etc.
meditor, I practise	*meditatus*, etc.
testor, I call to witness	*testatus*, etc.
moderor, I control	*moderatus*, etc.
populor, I devastate	*populatus*, etc.
partior, I divide	*partitus*, etc.
paciscor, I bargain	*pactus*, etc.
utor, I use	*usus*, etc.

(4) There are two methods in use of supplying in other verbs the much felt want of the perfect participle: firstly, by the ablative absolute; secondly, by *quum* with the subjunctive mood—as in (1) *Cognito Cæsaris adventu, Ariovistus legatos ad eum mittit*, Ariovistus, having heard of Cæsar's coming, sends ambassadors to him; and (2) *Epaminondas quum vicisset Lacedæmoneos apud Mantineam, atque ipse gravi vulnere se exæminari videret, quæsivit salvusne esset clypeus*, Epaminondas, having conquered the Lacedæmonians in the battle of Mantinea, and seeing that he was dying of a severe wound, asked if his shield were safe.

(5) The future participle active either denotes simple *futurity* or *intention and purpose*—as in *Dies futurus*, the day that will come; but *Abiit victurus*, he has gone for the purpose of conquering.

(6) The neuter of the perfect participle is often used as an abstract substantive—as in *Nam priusquam incipias* CONSULTO, *et ubi consulueris maturè facto opus est*, you want good counsel before you begin, and when you have taken good counsel you want ready action.

(7) Participles are occasionally used in Latin to avoid the use of conjunctions where several predicates are united in a sentence—as *Urbs capta et incensa jacet*, the city is taken, is burnt, and is laid even with the ground.

(Observe that the future participle occurs most frequently in combination with the verb *sum*—as in *Ille imperator domi rediturus erat*, that emperor was about to return home.)

Self-Examination Questions and Exercises.

What do you mean by a participle? How does it differ from the verb, and how does it differ from the adjective, and yet *partake* of both? What participles are those in the active voice, and what in the passive voice, in Latin? How are the deficiencies of Latin participles for the perfect active supplied? Give examples of the two different methods employed. What is the twofold notion in the future participle active? In what combination does the future participle active occur? What is often the sense of the perfect participle passive when used in the neuter gender? Give examples. Can you mention what may be termed an abbreviating use of the participle, and give instances of this peculiar usage. What is meant by the ablative absolute? and show by examples what participle it supplies.

Translate into English:

Imperator, quùm vidisset hostes a prœlio currentes, secundam legionem sequi jussit. Victimis cæsis, sacerdos Deos, pacem petiturus, invocat. Tyrtæus Græcus poeta, non miles, carmina compositâ exercitui recitavit. Mucius solus in castra Porsennæ vēnit, eumque interficere, propositâ sibi morte, conatus est. Quum civitas in labore assiduo reficiendæ urbis teneretur. Perseus rediit, belli casum de integro tentaturus. Quibus rebus cognitis, nautæ ad naves suos revertuntur. Pythagoras, Tarquinio Superbo regnante, in Italiam venerat. Nondum comperto, in quam regionem venisset. Cæsar exposito exercitu, ad hostes contendit. Ipsa suâ Dido concidit usa manu. Scripta tua jamdiu expectans non audeo tamen flagitare. Ille multa ausus, et multos osus, et præterea permultum gavisus ex hac terra abiet periturus. Hi soliti benè vivere de curis alienis nihil agunt. Hoc adeptus est contentus. Res adversus jampridem expertus accipere res meliores gavisus est. Has terras populatus, domi rediit. Regnum paternum partitus et cum patribus sanctissimum fœdus pactus, urbem, capere patriæ, adiit. Grande jusjurandum juratus, et suo gladio solo fisus ad bellum gerendum cum hostibus verterat. Cænati, non pransi, ad theatrum læti currunt. Ille, regem in itinere comitatus, et multum de regiis doloribus meditatus, se ad supplicationem Deorum recepit. Hæc omnia testatus, et sua scelera confessus, mortem libenter (*willingly*) obiit.

Translate into Latin:—

Having used his tongue in defence of (*pro*) his country, Cicero, Rome's greatest orator, dared not to use his sword. Having dined late in the day, and having accompanied his friend to his beautiful villa, he slept there. The goddess was queen of (*potens*) Cyprus, a very beautiful island, on which she had a lofty temple, where her altar was covered with fresh (*recens*) flowers. Having been wont to trust in his own sword, he neglected the worship of the gods. When these things became known the city surrendered itself to the enemy at its gates. The city was taken, burnt, and rebuilt by the same enemy. Why was he sent from home? was it to bring back war on his own country? There is no need now of *deliberation* (use *consulere*), but of *action*. The people being occupied in incessant labour were easily overcome (*superati*) by the enemy. Cæsar having conquered the Gauls, sought to conquer the Britons, and next to be the lord of Rome and of the Roman empire. Hercules offering his right hand, said he accepted the omen of the gods. Doomed to death, he rushed into the thick of his enemies. The victory of Cæsar being known, the citizens went out of the city, burnt it, and crossed the sea for another land. Having heard all these things, he resolved to bring them before the senate (*referre ad*), and to punish the enemies of the state. What good man, what faithful citizen, having known all this conspiracy (use conjunction), would not go and inform the consul? (*certiorem facio*). The sentinels (*vigil*) having breakfasted, fly away out of the camp.

XLVIII.

Rome (*continued*).

Pompeius' forces probably amounted to 100,000 men, while Cæsar had some 15,000. But these were old seasoned veterans accustomed to fight together under tried captains, and to be led to victory against all kinds of odds by their great leader, while the hosts of Pompeius were untried and without organization or community of feeling. Pompeius seems to have felt that his army, large as it was, was yet no match for Cæsar's little band of veterans, and for a long time he shrank from meeting them in pitched battle. At last, however, they met for the deciding struggle on the plain of Pharsalia, in the north of Greece. The victory remained with Cæsar; and Pompeius, seeing that his cause was lost, fled with all haste to Egypt with only 2000 followers. There he hoped to collect another army before Cæsar could follow. But the Egyptians, fearing he might take part in their internal dissensions, inveigled him into a boat and murdered him, cutting off his head and throwing the headless trunk into the sea. It was washed up on the shore, and his freedman recognizing it burned it on a funeral pyre made from a wreck which he found near it, and buried the ashes in the sand. A rude stone, on which his faithful freedman scrawled with a blackened stick the word "magnus" (great) was the only monument that marked the resting-place of the great Pompeius' ashes. Cæsar followed him to Egypt as quickly as he could, and on landing was greeted with the news that his great rival was dead. It is said that he wept when Pompeius' head was brought to him, and it may well be that so sorry an ending of such a brilliant career may have stirred his deepest emotions.

Battle of Pharsalia.

Death of Pompeius.

Cæsar found a quarrel going on in Egypt

THE MURDER OF JULIUS CÆSAR

between Cleopatra and her brother Ptolomæus for the throne of that country. Won by her surpassing beauty, he took the side of Cleopatra, and placed her securely on the throne. Then crossing to Asia Minor he encountered the rebel son of Mithridates, Pompeius' old enemy, and in five days completed the conquest of his kingdom. This was the campaign which he announced to the senate in the memorable despatch "*Veni, vidi, vici*," ("I came, I saw, I conquered"). He returned to Rome to arrange matters there, but in three months started off again for Africa, where Pompeius' party had again collected in formidable numbers. Another great victory dispersed them, and Cato, who was among the routed leaders of this revolt, committed suicide after the battle. Cæsar returned to Rome again; but almost immediately set off again to Spain, where the sons of Pompeius were gathering a force for one more stand against their father's conqueror. Once more Cæsar was victorious, and now at last he returned with some prospect of rest after his unbroken success in every part of the empire. There was no power at home or abroad capable of offering any further resistance to his will. He was in truth absolute master of the whole Roman world, and in all but name an absolute monarch. Honours and privileges the most unusual were poured upon him by the senate and the people. A statue in his honour was erected, with an inscription to "Cæsar the Demigod." Temples were dedicated to him; the name of one of the months of the year was changed to "Julius" in his honour. He was made dictator for life, consul for five years, "imperator" or commander in chief (a new title), tribune of the people, censor and chief pontiff. In fact, all the chief offices of the state were centred in this one man. It must be admitted that he made an excellent use of the powers so lavishly bestowed upon him; and had he lived a few years longer, the future of Rome and of the world might have been happier. He desired to admit the people of the provinces to the privileges of Roman citizens and even to introduce their most eminent men into the senate. And it was his hope that when he had reduced all things to order, and laid the foundations of peace and good government all through the empire, he might be able to hand on his power to some worthy successor. But his dream of reforms was unfortunately cut short. It was impossible that he should have escaped the malice and hatred of some and the envy of others. Possibly, too, there were genuine patriots and haters of arbitrary power who sighed to rid the world of one whom they could not but consider a usurper. At all events a conspiracy was got up to murder him, and amongst the conspirators were many whom he had loaded with benefits. The name best known to Romans of that time, as well as to us, was that of Junius Brutus, a man whom Cæsar believed to be his warm friend and supporter, and to whom he had shown the greatest favour. For the honour of human nature we must give to Brutus and his fellow assassins the benefit of the doubt, and assume that they acted from overwhelming sense of duty. They attacked their victim suddenly in the senate-house, and he fell pierced with no less than twenty-three dagger wounds, exclaiming "Et tu Brute!" (and you also, Brutus!) He was but fifty-six years of age. As a writer, or a statesman, or a general—any one of the three—he would have been amongst the greatest of his age. Combining these three capacities as he did, his place among the great men of history is second to none, and perhaps it ought to stand by itself above all others.

Cæsar in the East.

Cæsar supreme.

Assassination of Cæsar.

Great confusion followed his death. He had chosen for his heir his grand-nephew Octavianus, the son of his sister's daughter. But Octavianus was a youth of eighteen, and away in Greece completing his education there, like many of the young Roman nobles of the time. Besides, he had no official position, as Cæsar's powers were not hereditary The most powerful man in Rome was Antonius, the consul. He was Cæsar's minister and favourite, and it seemed natural that he should for the moment at least step into Cæsar's place until things settled down. A compromise with the assassins was made; but Antonius soon felt himself powerful enough to defy Brutus and his party, and they quitted Rome. In fact, as Cicero said, "the tyrant was dead, but the tyranny still lived"—in Antonius.

Octavianus.

Antonius.

But Antonius was not to have everything his own way for very long. Octavianus lost no time in returning home, to claim his inheritance nominally, but in reality to follow out the dreams of ambition which already had filled his mind. Why should not he attain the same great place in the government of the empire that his uncle had held? and why might he not even wear the crown which his uncle had refused only because the time was not yet fully ripe for the change?

But his caution and craft were not less than his ambition; and so at first he kept very quiet. His cause was steadily supported by a great many of Cæsar's old friends and supporters, and a considerable army gathered round his standard. In the civil war which broke out almost immediately between the senate and Antonius, he threw his whole influence into the scale with the former, and Antonius was defeated. But he was still powerful, and Octavianus saw that it would be better for him to follow Cæsar's example, and enter into an arrangement with the men who commanded armies rather than with the senate, who would probably deprive him of his command on the first opportunity. So Octavianus and Antonius and Lepidus, who all had large armies in the field, agreed to govern jointly, just as Julius Cæsar, Pompeius and Crassus had done twelve years before. They called themselves the triumvirate or government of three men, and claimed to be above the senate and the consuls and even the laws. To get rid of formidable opponents, each of the triumvirs drew up a list of

The Triumvirate.

Proscriptions.

the persons he required to be put to death, and thus the horrors of Sulla's proscriptions were once more seen in the streets of Rome. A brother of Lepidus and an uncle of Antonius were among the "proscribed"; but the most illustrious victim was the great writer, orator and statesman, Cicero. He had made himself too prominent in denouncing the usurpation of Antonius, and was too dangerous to be allowed to live. He fled, but was overtaken. His head was cut off and carried to Rome.

Meantime the republican leaders, Brutus and Cassius, had fled to the east—Brutus to Greece, Cassius to Syria. They ultimately joined their forces, now numbering some 50,000, at Philippi, on the borders of Macedonia. Here Octavianus and Antonius met them with an equally large, or even larger, army. A great battle was fought, in which the division under Cassius was defeated by Antonius, while Brutus got the better of Octavianus, who was suffering from illness at the time. Cassius, thinking all hope was gone, committed suicide. Brutus ventured to give battle again some weeks after on the same ground, and being utterly beaten, followed Cassius' example, and put an end to himself. Antonius and Octavianus were now masters of the situation. It was agreed that Antonius should rule the eastern and Octavianus the western provinces, while Lepidus was given Africa. Antonius soon fell completely under the influence of Cleopatra, the beautiful and accomplished, but unprincipled queen of Egypt, whose charms had fascinated even the great Julius.

Brutus and Cassius at Philippi.

While Antonius was indulging in the extremest forms of Eastern licence and luxury, instead of leading his legions against the enemies of Rome, Octavianus was quietly increasing his power and influence in Rome by his good government. He had much trouble to put down the piracy of Sextus Pompeius, son of the great Pompeius, who was at this time master of the seas, and had made the supply of corn for Rome a very difficult matter. Octavianus had no fleet, and was obliged to build one. At last, however, he utterly defeated Pompeius and Lepidus, who had united to oppose him. Lepidus was deprived of his command, and thenceforth gave no further trouble. Pompeius fled to Antonius, and was by him put to death. We saw that in the first triumvirate—that of Julius Cæsar, Pompeius and Crassus—the death of Crassus left Julius and Pompeius to fight out the struggle for supremacy without any third party to hold the balance. So now, in this second triumvirate, the defeat of Lepidus left Antonius and Octavianus face to face. Antonius still remained in Egypt with his bewitching mistress. But at last he saw that he must rouse himself to face the now threatening power of his rival. War broke out between them. A great naval battle was fought on the shores of the Adriatic at Actium. The ships of Antonius were both more numerous and larger than those of Octavianus, but the victory remained with the latter. Cleopatra, who was present in her own galley, fled in the heat of the action; her lover, whether from love of her or from cowardice, followed her, and left his fleet and his legions to look after themselves. Thus deserted by their leader, they soon submitted to Octavianus. The conqueror determined to pursue his defeated rival to Egypt. Antonius, in despair, believing Cleopatra to be dead, committed suicide. She was taken prisoner and brought before the victorious youth, upon whom she hoped her still transcendent beauty and wit might produce the same impression which had twice before enabled her to conquer the conquerors of the world. But when she found her hopes were vain, and that she was to be brought to Rome to grace his triumph, she determined that she would escape at least that crowning calamity. She was found dead, along with two of her attendants. It is not certain how she killed herself, but it is at least probable that the popular belief was well grounded, and that she put an end to her life by allowing a poisonous snake to bite her.

Battle of Actium.

Suicide of Antonius and Cleopatra.

Cleopatra was the last, and for us moderns the most famous, of the great Egyptian dynasty of the Ptolemies. Her surpassing beauty and wit, her unbounded profligacy, her connection with Roman history through Julius Cæsar and Mark Antony, and her romantic death, have combined to make her the most striking woman of her time. On her death Egypt became a Roman province

Egypt a Roman province.

The death of Antonius was probably most fortunate for the world. Had he overcome Octavianus, an utterly profligate and corrupt empire would probably have been established, but could never have lasted, and the old horrors of civil war and anarchy would have revived until some stronger and wiser ruler established himself firmly in power. Fortunately Octavianus was such a ruler, and more. He was a statesman of the highest order of genius; and the form of government which he was now about to establish was destined to prove, by its permanent endurance through many centuries, the profound wisdom of his views.

Effects of Antonius' death.

The times were ripe for such a man. The civil wars which began in the time of Marius had continued now for half a century. Every one was heartily tired of them; and so accustomed had people become to the sight of a military commander wielding the chief power of the state and overriding senate and people alike, that the mass of Romans were no longer shocked at it, and were quite ready to acquiesce in it, if it secured peace and order. Still there were many who looked back with regret to the old republican form of government, and fought hard to preserve what remained of it. Such men were capable of repeating the lesson to would-be kings which Brutus and Cassius had taught by their assassination of Julius Cæsar. Octavianus had laid the lesson to heart. He carefully avoided all appearance of kingly state. The name of king was studiously kept out of sight, and the old republican forms were

Policy of Octavianus.

preserved, while their spirit was totally changed. The policy of the republic had been to break up the kingly prerogative and distribute it amongst a number of different persons so that each could check the others.

Concentration of power.

But Octavianus set himself to gradually concentrate all these powers in himself, by means ostensibly legal. His influence, after Antonius' overthrow, was so great that the senate, to gain his favour, pressed upon him the office of *Imperator*, or permanent commander-in-chief of the army. This made him really the chief power in the state. Then he got himself made *Censor*, which enabled him to decide who should and who should not be a senator. He was also made *Principas*, or head of the senate, and *Tribune* of the people, as well as *Pontifex* or chief priest. So that he was now the legal and recognised head of the army, the senate, the people, and their religion; and these offices were bestowed upon him for life. To mark his peculiar position, he took the title of "*Augustus*," which was safer than the hated name of "king," and by this title he is generally known in history. Having got all the real power firmly in his grasp, he cared little for the outward show of superiority, and lived remarkably simply and quietly in Rome.

Literature.

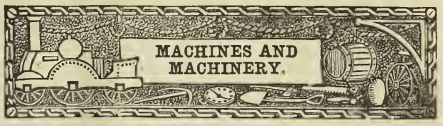
He encouraged literature, and loved to have men of letters about him. His reign was, in fact, the golden age of Roman literature. Virgil wrote his immortal epic poem, *The Æneid*, to celebrate the deeds of Æneas, the supposed ancestor of the Julian clan. Horace and Ovid flourished at this time also, and Livy wrote his history of Rome. There are perhaps no names in Roman literature better known to every one who has learned Latin than are these four, and they have justly won for the Augustan age the very first place in Roman classical literature. The chief characteristics of the literature of this age originated in the leading features of the Roman character. The Romans were a practical and not a speculative people; pure speculation, therefore found little favour and encouragement in the literature they produced.

Having firmly established his government, Augustus, as we may now call him, set to work

Affairs of the empire.

to arrange the affairs of the empire. The reader will remember that at the death of Julius Cæsar, the conquered provinces included Spain, France (or Gaul), Greece, and Macedonia, Asia Minor, Syria, and portions of Africa, besides all the islands of the Mediterranean. Augustus added little to the empire, except the country south of the Danube, which he made the boundary of the empire for the greater part of its length, and he left his advice to his successors that they should refrain from conquering fresh territories, and aim only at strengthening their frontiers.

His advice was followed, except that Britain was finally conquered in A.D. 51, by the Emperor Claudius, having been abandoned for a hundred years after Cæsar's landing there; and Dacia, the modern Roumania, was incorporated by Trajan in A.D. 106.



VIII.

Machine Tools.

There is no need to attempt here a description of what is commonly understood by the word *tool*, nor the meaning of the word *machine*; it will suffice to say that there is a class of appliances in every-day use in the workshop that are somewhat more complicated than tools, though they scarcely deserve the name of machines, and it is to such that we are about to devote a little attention.

Tools are made more complicated either for convenience' sake, or, as it is commonly stated, to gain power; the fact being that no power is *gained* by the use of any machine, unless by *gaining* we agree to mean the more complete utilization and the more effective disposal of the power that is already at the command of the workman. We generally find that by the use of what may be called a machine tool, not only is time economized, but in most cases the results far exceed in accuracy those obtainable by more simple means.

The number of machine tools constructed for special operations is very great, so that we shall have to be content with a reference to a few of those that are of more general application, such as sawing, hammering, and boring appliances.

One of the most simple and ordinary methods of economizing time and power is by rendering an intermittent motion continuous. Now in using an ordinary hand-saw we have not only an intermittent action, but a great loss of time and energy; for after each cut the saw must be drawn back before another cut can be made. These disadvantages are overcome by the use of *circular saws*, which are turned either by steam power, by means of a treadle, or more rarely by a cranked handle. This complication of the tool renders it necessary that the saw shall be stationary and that the material itself shall be moved as it is being cut. This is indeed a general rule in such cases. To facilitate the motion of the work and to afford it the necessary support, a bench is used, and through a slit in its top the saw projects from below. An adjustable guide is fixed to the bench at the side of the saw, so that the work may be pressed against it and slowly advanced to the cutting edge; the greatest uniformity being thus secured in the similar parts of doors, sashes, etc., when large numbers are being prepared at the same time.

The action of the hammer is, like that of the hand-saw, intermittent; but a little consideration will show that it is impossible in this case to obtain a continuous action without producing a mere pressing machine, and so losing all the characteristics that make the hammer so useful a tool. The blow given by a hammer is produced by its momentum, and this momentum may be increased, and so the

blow be made more powerful, by increasing either the *weight* of the hammer or the *speed* at which it moves. The increase of speed is attained by the use of a longer handle, but a practical limit is soon reached in this direction as well as in the matter of weight. This limit of weight, however, disappears when the hammer proper is supplemented by a most simple mechanical contrivance. The construction of the simplest forge-hammers will be readily understood by imagining an ordinary hammer with its face resting on an anvil and the far end of its handle firmly pivoted to some fixed object. If now the head of the hammer is raised and then released, it will fall upon the anvil with a force proportional to the height of its fall and to its weight. The chief difference between hammers working on this principle consists in the methods of raising the hammer-head,—which, however, mostly agree in having a wheel so situated that as it is revolved certain projections fixed to it shall effect this object. In the *tennant-helve* these projections act upon the head itself, while in the *belly-helve* the lifting apparatus is fixed between the head or *helve* proper and the pivots that it swings upon. In the *tilt-hammer* the raising is effected by depressing an elongation of the shank behind the pivots, so that the hammer itself is not encumbered with any machinery tending to hinder the workman from getting at every side of his work as it is being hammered.

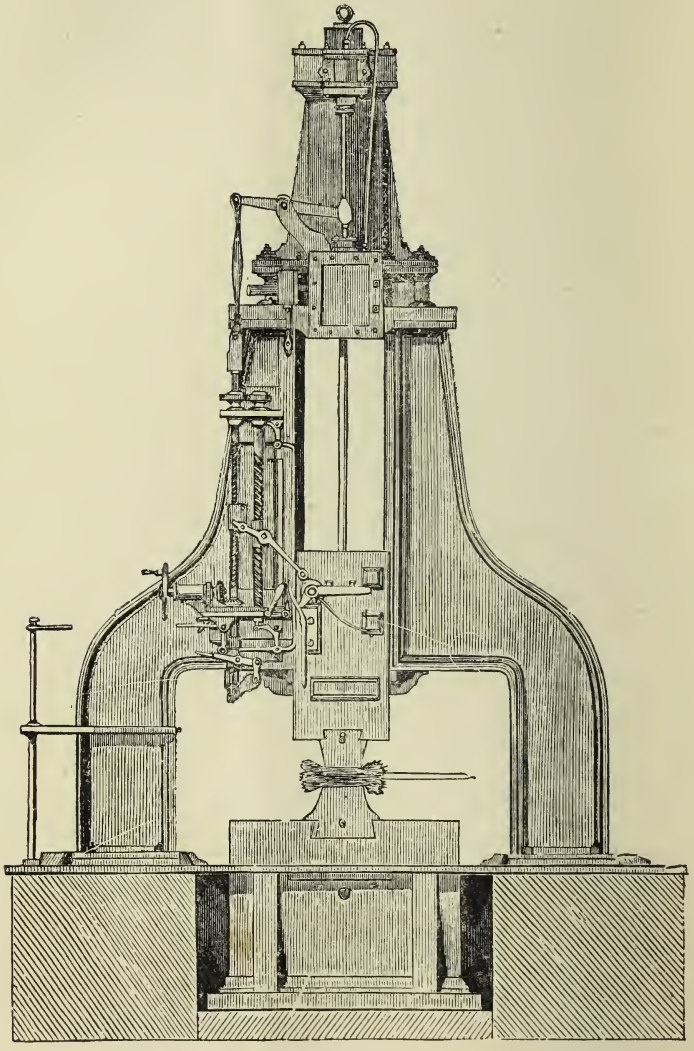


FIG. 26.

But the greatest favourite of all mechanical hammers is the Nasmyth steam-hammer, a

representation of which is given in fig. 26. The mass of iron that is equivalent to the hammer-head is connected with a rod, which has a piston at its other end working in an inverted cylinder. The hammer block is raised by admitting high-pressure steam under the piston, and falls by reason of its own weight when the steam is let out. The descent of the hammer may be so perfectly regulated, however, by the machinery shown on the left of the figure, that it can, if necessary, be brought down gently enough to crack a nut without crushing the kernel. This machine has many advantages over the other hammers referred to, one of the chief of which is that the face of the hammer-block is always parallel with the face of the anvil, so that the blow delivered is vertical, whatever may be the thickness of the intervening mass. Where the hammer works at the end of a lever, it is obvious that it moves in a circle, and that its face forms an angle with the anvil top, which increases as the distance between them becomes greater. In setting up any mechanical hammer, great care should be given to the fixing of the anvil so that it shall be enabled to resist the tremendous shocks to which it is

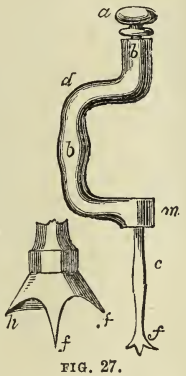


FIG. 27.

Just so holes may be bored with tools of the most primitive construction, but in the vast majority of cases we can obtain a better and more speedy result by the use of slightly more elaborate apparatus. The simplest way of making a hole is by pushing a pointed taper instrument through the substance to be perforated, or by the use of a bradawl, which is provided with an edge instead of a point, and so makes a hole of uniform diameter. But in neither of these cases do we get a *clean* hole, for the substance of the object bored is merely pushed on one side, and will tend to return more or less to its original position when the obstacle is removed. These tools, then, although preferable to any others in certain cases, are so radically imperfect in their action as hole makers that it may be taken for granted that the principle of action must be improved before it can be advantageous to elaborate the instrument. In other words, it is always bad policy to attempt improvements in detail, when the principle is faulty; and it needs but little observation to see that successful inventors in certain measure realize this fact, though perhaps too often instinctively

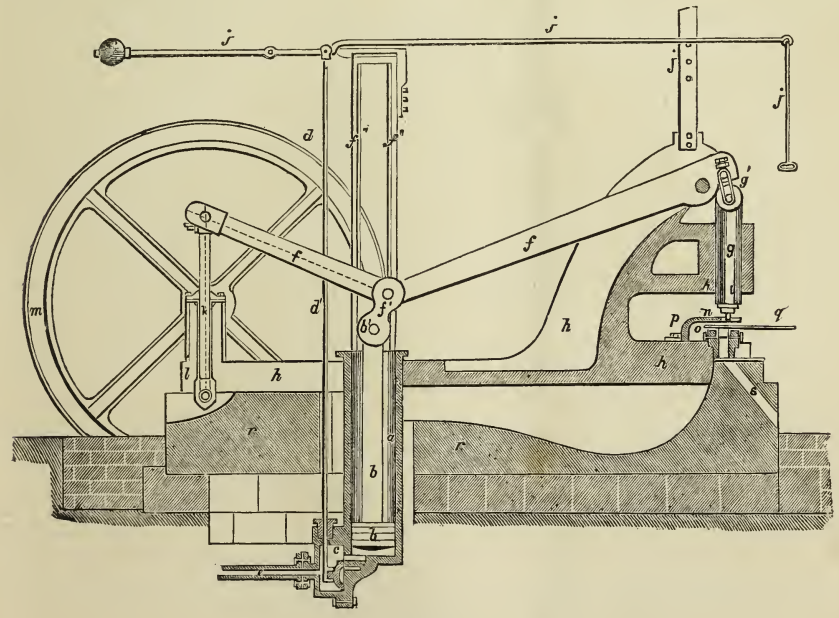


FIG. 28.

subjected, and the least springiness or "give" in its foundations must be avoided, otherwise the blow will be moderated and a part of its energy lost.

Hammering is one of the simplest operations, yet we have seen how with advantage the simple hammer may be complicated into a machine.

rather than reasonably. In mechanical inventions, as in the affairs of human life, it is always but labour thrown away to endeavour to improve what is based on misconception and error.

To make a clean hole it is necessary to cut out and remove that portion of the substance that exists where the hole is required. If the

material is thin, this may be done by a *punch*, which removes the part in one piece. Punches for leather may be described as tubes with sharp edges, which are driven through the material by a blow from a mallet while the leather is supported by a wooden block. The piece cut out remains in the punch. For perforating harder substances, such as sheet metal, it is preferable to have a solid-ended punch, which drives the piece cut out into a hole in the bed on which the metal rests, the bed having a steel face.

Such are the tools which have been combined with such simple machinery that shall best adapt them to their varied special uses. In the pliers-shaped instrument with which railway tickets are clipped, the power of the simple punch and mallet is given up for the sake of convenience. Here great power is not needed, but convenience and portability are indispensable; the tool is thus adapted to produce the required results, and this simple fact explains its universal adoption.

But where power is the chief requisite, as in punching holes in boiler plates, it becomes worth while to give up all attempts at portability that we may enable the machine to perfectly perform the very different sort of work to that just referred to. Fig. 28 represents a punching machine of this sort, invented by M. Caré. The punch itself is fixed to the lower end of the cylinder *g*, *q* is the plate being punched, and *s* is a hole made to allow the pieces punched out to fall away that they may not impede the action of the machine. The punch is driven downwards with great force by means of steam, which passes through *e* into the cylinder *a*, driving upwards the piston with its rod *b* and the crosshead *b'*, *f''* which works in the frames *f'*. It will readily be seen how the power so obtained is concentrated by the lever *f*, and transferred to the cylinder *g*.

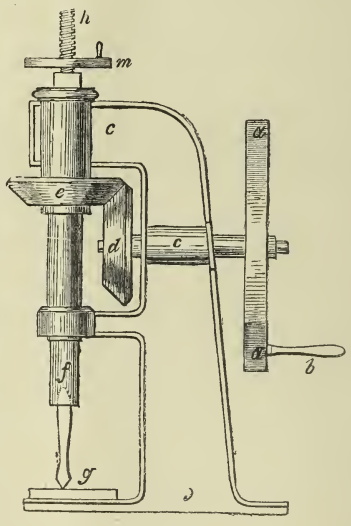


FIG. 29.

The cursory observer would see but little resemblance between this massive and powerful piece of machinery and the railway porters' ticket punch; but the careful student at once recognises the same tool in each case, but developed in quite opposite directions.

The most ready method of making holes in thin materials is by punching, but it is obvious that this process must altogether fail where the object to be perforated has more than a certain thickness. In this case we must be content to *bore* the hole and remove the substance in small pieces. We may regard the gimlet as a practically perfect tool for boring wood, because it makes its own way by means of the small taper screw at the point, at the same time that it cuts away the wood by the sharp edge of the screw-like groove that extends along the thickest part of the tool. This groove also serves as an exit for the waste material. This high degree of perfection, however, stands quite as much in the way of any useful attempts to make a machine of it as do crudeness and imperfection in the case of the bradawl. It may be rightly argued that the gimlet is slow in action, but this is a point in its favour rather than otherwise, as this slowness exactly suits the usual rate at which it can be used by hand. If we wish to increase its speed of action we must be content to give up its self-propelling power, and of course be prepared to compensate it for this important loss. The *brace-and-bit* may be regarded as a gimlet modified in the way indicated, with the improvement that the cutting is done by the front or end of the tool instead of the side. This, however, is not an unmitigated improvement, for it precludes the possibility of making centre-bits to bore holes less than about $\frac{1}{4}$ of an inch in diameter; though at the same time the action of the centre-bit pre-eminently fits it for making larger holes. The figure (27) shows an ordinary form of brace-and-bit with an enlarged representation of the cutting end of the centre-bit. The propelling force is obtained by pressure on the knob *a* by the workman's hand or chest, according to whether the hole is perpendicular or horizontal, while continuous revolution of the bit is obtained by means of the crank *b*.

In the boring of metals the centre-bit is replaced by the drill *g* (fig. 29), and the increased pressure that is advantageous is obtained by a screw instead of the pressure of the workman's body. Fig. 29 illustrates this class of machine, the screw *h* turned by the wheel *m* serving to press the drill point downwards, and also shows a very convenient method of obtaining the rapid revolution of the drill.

The boring of cylinders for steam-engines, blowing-machines, working-barrels of large pumps, and other hollow cylinders of cast-iron in which pistons work, requires very powerful and accurate machinery. The cylinder is cast hollow, and the object to be attained by the boring-machine is to convert the interior into a true cylinder.

The immense number of machine tools in every-day use renders it quite impossible for us to give anything like a complete account of them; but if the reader understands the principles and advantages of a few such as those selected for description above, it will not be difficult for him to appreciate the special points of most others that he may happen to come across.

XXVI.

Voltaic Electricity (*continued*).

If now our readers turn back to fig. 90, p. 793, they will see that in the ordinary form of Wheatstone's Bridge the two conductors AD, DC, are replaced by the German silver wire, the breaks at *c* and *d* representing the breaks between the side strips B, D, and the longitudinal strip A. In using the Bridge it is usual to insert a wire of known resistance or a rheostat in one of these breaks, say *r*; the wire the resistance of which is to be ascertained is placed in the other break. The pointer C is then moved along the wire until a point is reached where no deflection of the galvanometer needle takes place, and the currents passing round the galvanometer must therefore be equal. If this result is obtained when the pointer rests on the middle point of the scale (500), the resistance of the wire to be measured, r_3, is evidently equal to that of the known wire, *r*. If however the pointer has to rest upon any other point of the scale than the middle, then the resistance of r_1 is to that of r_3 as r_2 is to r_4. Suppose, for instance, the pointer to rest at one-third of the length of the scale from B, the resistance of r_3 would evidently be twice that of *r*. In addition to thus measuring the resistance of a wire by Wheatstone's Bridge, we may perform the reverse operation—that is, we may measure the lengths of different pieces of wire of which we know the resistance. Suppose, for instance, we have several lengths of copper wire, all of the same diameter and conductivity, by putting in one of the breaks a known length of the wire, and putting the other lengths successively in the other break, the points on the scale at which the index has to be placed to secure the equilibrium of the galvanometer needle will, as before, indicate the respective resistances, which being directly as the lengths of the wires, will give us the information required.

Determination of internal resistance.

By Wheatstone's Bridge the internal resistance of a cell may be determined and evaluated in a length of copper wire. In one of the breaks a rheostat is placed, and in the other the element the internal resistance of which has to be guaged. The deflection of the galvanometer needle is then noted. A second element is then joined to the first so as to form one of double size—that is to say, the two zincs and the two coppers are respectively joined together—which will, of course, halve the internal resistance. A length of wire is then added to the circuit by the rheostat until the same deflection of the galvanometer needle is obtained as at first. The length of wire added to the circuit obviously represents half the resistance of the single cell, and therefore double that length of wire will represent the whole resistance. The length of wire thus representing the internal resistance of a cell or battery is known as the *reduced length of the circuit*.

Units of resistance.

Hitherto we have considered only the relative proportions of resistances to each other, but it is necessary for practical purposes to have some definite unit of resistance to which reference may be universally made. Amongst the various units which have been proposed we may mention that of Siemens, which consists of the resistance of a column of mercury one metre high, and having a sectional area of one millimetre, which at 0° C. is taken as the unit.

The unit of resistance most generally adopted is, however, that fixed by a Committee of the British Association specially appointed for the purpose, and which is known as the "British Association unit." This unit depends upon the relation between a current, the force it exerts upon a magnet, and the distance and strength of the magnet. The term Ohm, or Ohmad, is applied to this unit, which is equal to 1·0486 of a Siemens' unit.

Electrodynamics.

Under this term is included a consideration of those laws which govern the action of currents upon each other or upon magnets; it, in fact, signifies electricity in motion as opposed to *electrostatics*, which treats of electricity at rest.

Laws of attraction and repulsion of currents.

The investigation of the action of currents upon each other was first undertaken by Ampère, shortly after Oersted's discovery of the action of a current upon a magnetic needle, to which we have before referred. His researches soon led to the enunciation of two fundamental laws, which are as follows:—

1. *Two currents which are parallel, and in the same direction, attract one another. Currents which are parallel, but in opposite directions, repel one another.*

2. *Two currents forming an angle attract one another if they are in the same direction with regard to the apex of the angle; if they are travelling in opposite directions with regard to the apex of the angle they repel one another.*

The apparatus usually employed for the demonstration of these laws is represented in

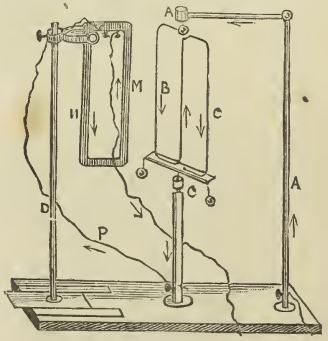


FIG. 92.

Apparatus employed.

fig. 92. Two brass columns, A and D, of equal height, with a shorter column between them, are fixed on a stand, the column D being pro-

vided with a multiplier of twenty turns, M N, which greatly increases the delicacy of the instrument. The movable clamp by which the multiplier is attached to the column D gives facility for its being adjusted at any height and in any position. In the short tube, which is hollow, is made to slide a brass tube carrying a mercury cup, *c*. The column A is also provided with a mercury cup, through the bottom of which is an extremely small aperture, into which a sewing needle is passed, the needle being attached to a small copper ball. The needle-point extends into the mercury in the cup, and is freely movable in the aperture through which it passes. From the small copper ball proceeds a bent wire frame, B C, revolving in the mercury cup *c*, and balanced by two copper balls attached to the ends.

The apparatus is usually worked with a battery of four or five Bunsen's cells, and we will suppose the current to travel in the direction of the arrows, ascending by the column A to the mercury cup *a*, descending thence through B C to the cup *c*. From the central column it then passes to the multiplier by the wire P, and after traversing M N it returns to the battery by the wire Q. If before the current is allowed to pass the frame B C be turned so as to be in the same plane as the multiplier, with the side B opposite the side M, the movable frame will be repelled as soon as the connection is made, thus proving the second part of the first law of Ampère. To demonstrate the first part of this law the multiplier must be reversed, as shown in fig. 93. In this arrangement, as shown by the arrows, the current will be in the same direction both in the multiplier and in the adjacent part of the movable frame. Consequently attraction between the frame and the multiplier results; and if the former be removed out of the plane of the latter it tends to return to it.

Use of the apparatus.

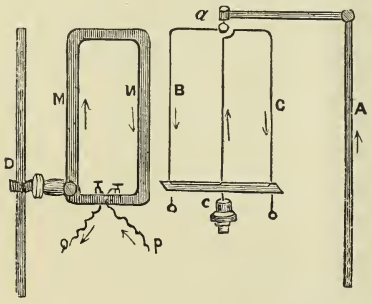


FIG. 93.

The law of angular currents enunciated above may be proved by the modification of the apparatus just described as shown in fig. 94. As will be seen on reference to our illustration, the movable frame B C is replaced by another movable piece of different shape. To prove the first part of the law the apparatus is arranged as in the figure, when attraction ensues, if the movable part be moved when the current passes in the same direction through it as through the multiplier.

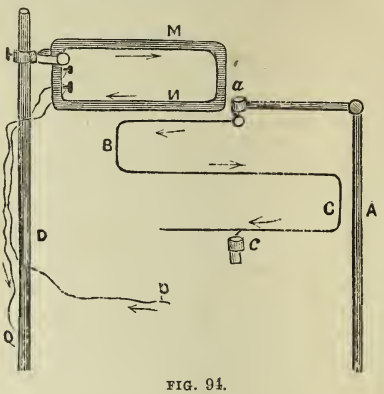


FIG. 94.

The second part of the law is proved by arranging the apparatus as in fig. 95. Here

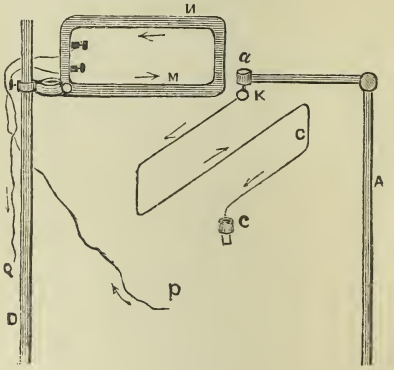


FIG. 95.

the currents are in different directions, and repulsion between the multiplier and the movable frame ensues.

From the preceding laws of Ampère, it follows that *in a rectilinear current each element of the current repels the succeeding one, and is itself repelled.*

Repulsion of separate elements of a current.

An ingenious piece of apparatus to prove this was invented by Faraday. It consists of a piece of copper wire bent in the shape of the letter U, the ends of which dip into two mercury cups. This wire is suspended from one end of a very delicate balance. When the mercury cups are connected with the poles of a battery, the wire perceptibly rises, sinking again when the current ceases to pass. Here the mercury cups and the copper wire form two elements in the circuit, the former being fixed, the latter movable; consequently the repulsion between these two elements of the circuit results in the raising of the copper wire.

Another very important topic for consideration in dealing with the laws of currents is

the action of currents passing through coiled wires. It has been demonstrated that these so-called *sinuous* (winding) currents are in their action equal to rectilinear currents, having the same length as their projection. In other words, if you draw a line from one end of a coiled wire to the other, the action of a current passing through the coiled wire will be equal to that of a current passing through a straight wire of the length of the line joining

Sinuous currents.

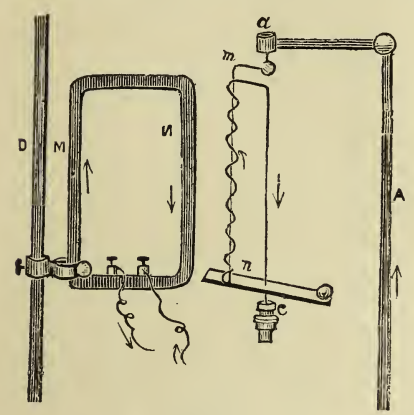


FIG. 96.

the two ends of the coiled wire. This fact may be demonstrated by the same apparatus as that employed for demonstrating the laws of the attraction and repulsion of currents. The apparatus is arranged as shown in fig. 96. The multiplier is arranged vertically, and near it is placed a circuit half straight and half sinuous. Upon allowing the current to pass, neither attraction nor repulsion takes place, showing that the action of the sinuous portion of the current *m n* is equal to that of the rectilinear portion *n o*.

X.

The Second Period of English Literature (*continued*).

That the English of the fifteenth century varied considerably in different counties is shown by the following quaint anecdote of the period: "That comyne Englishe that is spoken in one shyre varyeth from another; insomuch that in my dayes happened, that certayn merchaunts were in a shipp in Tamyse, for to have sailed over the see into Zelande, and for lacke of wynd they taryed atte Forland, and went to land for to refreshe them; and one of them named Sheffelde, a mercer, came into an hows, and axed for mete, and specyally he axed arter egges; and the good wyf answerde, that she coude speke no Frenshe. And the merchaunt was angry, for he also coude speke no Frenshe, but wolde have hadde egges, and she understode him not. And thenne at last another sayd that he wold have ceiren—thenne the good wyf sayd that she understode him well." The good wife no doubt knew eggs only as *eyren* or *eyer*, and thus thought her interlocutor was speaking French, while he was simply using the terms understood in London, but strange as a foreign tongue to the good country folk at the Foreland.

Various dialects in England.

With regard to spelling, every man seems to have done what was right in his own eyes. Until the art of printing had so far multiplied books as to make one region familiar in some degree with the method of spelling in another, there could be no fixed rule or system. Any combination of letters that in some degree indicated the word to be represented, satisfied the orthographical need of the writers, and the same word is often found spelt in different ways within a few pages. Thus in many writings of the fifteenth century the spelling is far more irregular and unsettled than in the works of Chaucer and Gower, and sometimes appears ludicrous in its grotesque barbarity. The following lines from the poem written about 1417 on *The Siege of Harfleete* (Harfleur) and *The Battalye of Agyncourte* will illustrate the spelling of the period:—

Irregular spelling

Sent Jorge be fore our Kyng they dyd se,
They trompyd up ful meryly,
The grete battell to gederes zed;
Our archorys theiy schot ful hartely.
They mayde the Frenchè men faste to blede,
Her arrowys they went with full good spede.
* * * * * *
Denters of dethe men myzt well deme,
So fercelly in ffelde theye gav fythe.
The heve upon here helmyts schene
With axes and with swerdys bryzt."

[This would be in modern English: Saint George (the banner of) before our king they (the French) did see (carried.) They tramped up full merrily; the great battles (or hosts) together set (rushed at each other); our archers shot full heartily. They made the Frenchmen bleed fast; their arrows went with full good speed . . . Dinters (piercers) of death men well might deem (them), so fiercely in the field they began to fight. They struck upon their shining helmets, with axes and with bright swords.]

Warton justly observes that these verses are far less intelligible than those of Chaucer and Gower, written nearly half a century before; but he adds that provincial must not be mistaken for national barbarisms; for that separate pieces cannot fairly be adduced as proofs of the state of style. "The improved dialect," he says, "which yet is the estimate of a language, was confined only to a few writers, who lived more in the world and in polite life, and it was long before a general change in the public phraseology was effected. Nor must we expect amongst the minstrels, who were equally care-

Uplandish or provincial idioms.

less and illiterate, those refinements of diction which mark the compositions of men who professedly studied to embellish the English idiom."

In the Lowlands of Scotland, during this period, the language called the "Inglis" was spoken and written; and though there was probably much difference in pronunciation (as indeed indicated long afterwards by Shakespeare in his humorous scene between the Scotch, Irish, and Welsh captains in Henry V.), there was little essential variation between the languages of the Englishman and the "Sassenach," or Lowland Scot. Indeed, North Britain produced, in JOHN BARBOUR, GAWAIN DOUGLAS and others, poets who could well hold their own against any writers among the Southrons.

English spoken in the Lowlands of Scotland.

Towards the end of the period, the mutability of which worthy Master Caxton complained in a great measure ceased, as the effects of the art of printing became more and more felt. In the sixteenth century the English language was fixed in the form in which it still continues—for it is remarkable in how many particulars a good strong "Saxon" style of the present day resembles the diction of the best writers, even of the earlier part of the sixteenth century. Though certain words and phrases become obsolete and are replaced by others, and though the language is enriched by the introduction of terms derived from the Latin and Greek, the structure remains the same in its essentials. Even attempts at elegance are found in the prose writings of SIR THOMAS MORE, and the poetry of SIR THOMAS WYAT and the EARL OF SURREY. More's English was founded upon his Latin style, and differs considerably in construction and in the frequent use of Latin words from the ruder and simpler method of his predecessors, who seem to have written as they spoke, without much solicitude as to ease, polish, and elegance in their works.

The language more uniform in the sixteenth century.

Writers of the time of Henry VIII.

"The prevailing fault of English diction in the fifteenth century," says Campbell, "is redundant ornament and an affectation of anglicising Latin words." In this pedantry and use of "aureate terms," the Scottish versifiers went even beyond their brethren of the south. From this censure the poet excepts Dunbar, whom he credits with simplicity and lyrical terseness; but of the others he says, "When they meant to be most eloquent, they tore up words from the Latin, which never took root in the language, like children making a mock garden with flowers and branches stuck in the ground which speedily wither." Though this criticism is somewhat severe, it certainly hits the characteristics of the second period of English literature.

Latin words introduced.

One of the earliest, in point of date, among the writers of the fifteenth century, is THOMAS OCCLEVE, "the scholar of Chaucer." Both Warton and Hallam decry Occleve, the former speaking of him as "a cold genius, and a feeble writer," and the latter declaring that "the poetry of Occleve is wretchedly bad, abounding with pedantry, and destitute of grace or spirit." Later critics have considered that justice has not, on the whole, been done to Occleve, who appears to have been a shrewd observer, and has left us several curious particulars of the manners of his times. His is, moreover, the merit of transmitting to posterity the honoured features of Chaucer. "Thomas Occleve," says Speight, "for the love he bare to his master, caused his picture to be truly drawn in his book (*De Regimene Principis*) dedicated to Henry the Fifth," and it was from this portrait, we are told, that all our prints of the poet, as well as the head on Chaucer's monument, are taken. Occleve's chief poem is a translation of *Egidius de Regimene Principis*, a treatise on the art of government. Among the other works of Occleve are the *Fable of a certain Emperess*, *Consolation effered by an Old Man*, *Dialogue to a Friend*, *Dialogue between Occleve and a Beggar*, *Pentastichon to the King*, etc., etc.

Thomas Occleve, abt. 1370—1354.

"De Regimene Principis."

A writer of far greater importance than Occleve was JOHN LYDGATE, the monk of Bury St. Edmunds in Suffolk. Lydgate was not merely a learned monk, he was also a travelled man, and had studied the Italian and French poets, especially Dante, that glorious sun in the sky of Italian literature. He also studied Boccaccio and Alain Chartier. Lydgate was a man of varied talents; he was another of the followers of Chaucer, whose tone he seems partly to have caught in more than one of his works, especially in the *Troy Boke, or Destruction of Troy*, a translation or paraphrase of Guido de Colonna's romance, *Historia Trojana*. The descriptions of morning, the return of spring and of sylvan scenes, are here and there worthy of Chaucer himself. The following description of a woodland glade is in Lydgate's best style for facility and grace, and gives a specimen of the more elegant English of the period as compared with the rough simplicity of the poem on *Agincourt*:—

John Lydgate, 1375—1461.

Story of Troy.

"Tyll at the last, among the bowes glade,
Of adventure, I caught a pleasaunt shade;
Ful smothe, and playn, and lusty for to sene,
And softe as velvette was the yonge grene:
Where from my hors I did alight as fast,
And on a bowe aloft his reyne cast.
So faynte and mate of werynesse I was,
That I me layd adowne upon the gras,
Upon a brincke, shortly for to telle,
Besyde the river of a cristall welle;
And the water, as I reherse can,
Like quicke-sylver in his streames yran,
Of which the gravell and the bryghte stone,
As any golde, agaynst the sun yshone."

Lydgate was a man of many talents, and could write in very various styles. We are told that if "a disguising was intended by the Goldsmiths' Company, a masque before his Majesty at Eltham, a May-game for the sheriffs and aldermen of London, a mumming before the Lord Mayor, a procession of pageants from the Creation for the festival of *Corpus Christi*, or a card for the coronation, Lydgate was consulted and gave the poetry." Ritson enumerates

a catalogue of two hundred and fifty-one works by Lydgate. Among these are epic poems very lengthy and perhaps tedious according to modern ideas, but suited to the tastes and requirements of his day, and for their length Lydgate apologises, saying:—

Lydgate's apology for prolixity.

"For a story which is not plainly told,
But constreyned under wordes few,
For lack of truth, wher they ben new or olde,
Men by report cannot the matter shewe;
These oakés greaté be not down yhewe
First at a stroke, but by a long processe;
Nor long stories a word may not expresse."

The foregoing lines are from Lydgate's *Fate of Princes*, one of his longest poems. The *Siege of Troy* contains nearly thirty thousand lines. Æsopian fables, veracious chronicles, satirical pictures of the manners of his own time, and even merry ballads, all came within the scope of the versatile monk's genius. Of his talent in the two last-named departments we have evidences in his *London Lyckpenny*, and *The Prioress and her Three Wooers*. Mr. Halliwell, who has edited a collection of Lydgate's shorter poems, suggests that *Lyckpenny* should be read "Lackpenny," and certainly it would suit the sense better, for the poem gives a humorous account of the author's walk through London streets, and how he could not speed with an empty purse, being unable to dine at Westminster, or to buy the velvet satin and lawn offered for sale in "the Cheepe," or even purchase back the hood stolen from him, and hanging amid "much stolen gear" for sale in Cornhill. The following lines will give an idea of the humour of the *London Lyckpenny*. The author has visited the various courts at Westminster, and now betakes himself to London. He tells us (the spelling is modernized in the extract):—

The London Lyckpenny.

"Then unto London I did me hie,
Of all the land it beareth the price.
'Hot peas-cods!' one began to cry,
'Strawberry ripe,' and 'Cherries in the rise'
(branch or twig, from the German *Reis*).
One bade me draw near and buy some spice.
Pepper and saffron they 'gan me bid,
But, for lack of money, I might not speed.

Then to the Cheepe I 'gan me drawne
Where much people I saw for to stand;—
One offered me velvet, silk, and lawn;
Another he taketh me by the hand:
'Here is Paris thread, the finest in the land.'
I never was used to such things, indeed,
And, wanting money, I might not speed.

Then went I forth by London stone,
Throughout all Canwyke Street.
Drapers much cloth me offered anon.
Then comes me one cried, 'Hot sheep's feet.'
One cried, 'Mackrell!' 'Kysses green,"
another 'gan greet,
One bade me buy a hood to cover my head,
But, for want of money, I might not be sped.
* * * * * *

Then into Cornhill anon I yode,
Where was much stolen gear; among
I saw where hung mine own hood
That I had lost among the throng.
To buy my own hood I thought it wrong;
I knew it, well as I did my creed;
But, for lack of money, I could not speed.

The taverner took me by the sleeve,
'Sir,' says he, 'will you our wine assay?'
I answered, 'That cannot much me grieve—
A penny can do no more than it may.'
I drank a pint, and for it did pay:
Yet sore a hungered from there I yede,
And, wanting money, I could not speed."

Lydgate lived to be a very old man. Though a contemporary of Chaucer, being born in 1375, he survived till 1461.

This period produced a royal poet, in the person of the chivalrous and accomplished James I. of Scotland. Taken captive on a voyage to France, the boy-prince—then only ten years old—was confined by Henry IV. in Windsor Castle. Looking out of the window of his prison to beguile his captivity with the sight of free people, "to see the world, and folk that went forbye," he caught sight of the Lady Jane, or Joanna Beaufort, daughter of the Earl of Somerset, walking in a garden. "The fairest or the freshest younge flower," says the young poet, "that ever I saw methought before that hour. For which sudden abate, anon astart, the blood of all my body to my heart." The vision of the fair young girl awoke the poetic faculty of the royal capive, and forthwith he began to indite verses in her praise. He describes how he watched for her appearance, and how, when she departed, it seemed to him "the day was turned into night." The story of the boy-prince had a more appropriate ending than often favours the close of such a romance of real life. The royal captive in due time was set free, and married the Lady Jane. His career as a king, however, was unfortunate. Like many an ardent reformer, he interfered with too zealous a haste in the affairs and privileges of a turbulent nobility, and after a short and disturbed reign perished at Perth by assassination. Under the title *A Royal Poet*, a charming sketch of the episode of James and the Lady Jane is given in the graceful *Sketch Book* of Washington Irving.

James I. of Scotland: 1394–1437.

The captive prince and the Lady Jane Beaufort.

James was undoubtedly far in advance of his time in the elegance and facility of his style. *The King's Quhair* (or King's Choir) is his chief work. Two popular poems descriptive of the manners and humours of his countrymen have been ascribed to him. They are respectively entitled *Christ Kirk on the Green*, and *Peebles to the Play*. In the former the poet satirically records the want of skill of his countrymen in the science of archery. One archer breaks his bow, the second shoots wide of the mark, and the arrow of the third rebounds harmlessly from a leathern doublet. There is some doubt as to the authorship of the two satirical poems in question, but various high antiquarian authorities, with Sir Walter Scott at their head, ascribe them to James.

"The King's Quhair," etc.

The following lines will give an idea of the grace and literary merit of James's verses, and exhibit him as a poet far in advance of his time. The young captive prince has been bewailing his imprisonment, his "deadly life full of pain and pennance, saying right thus: What have I guilt to fail, my freedom in this world, and my pleasaunce." He goes to the window to beguile his captivity with a view of the free world without, and in the garden he sees walking a fair lady. This is the Lady Jane

Beaufort. He tells us this in words full of the pining melancholy of the prisoner:—

"Bewailing in my chamber, thus alone,
Despaired of all joy and remedy,
Tortired of my thought, and woe-begone,
And to the window 'gan I walk in by,
To see the world and folk that went forbye.
As for the time, though I of mirthis food,
Might have no more, to look it did me good,
Now was there made, fast by the tower's wall,
A garden fair; and in the corners set
An arbour green, with wandis long and small,
Railed about, and so with trees set
Was all the place, and hawthorn hedges knet.
That lyf was none walking there forbye,
That might within scarce any wyght espy.
So thick the boughis and the leavis green
Beshaded all the alleys that there were,
And mids of every arbour might be seen
The sharpe greene sweete juniper
Growing so fair with branches here and there
That as it seemed to a lyf without,
The boughis spread the arbour all about.
* * * * *

. . . I saw, walking under the tower
Full secretly, new comen here to plain,
The fairest or the freshest younge flower,
That ever I saw, methought, before that hour,
For which sudden abate, anon astart
The blood of all my body to my heart.
And though I stood abusit tho a lite,
No wonder was; for why, my wittis all
Were so overcome with pleasance and delight
Only through letting of my eyen fall
That suddenly my heart became her thrall
For ever of free-will—for of menace
There was no token in her sweete face."

After a passage full of tender description the poet goes on:—

"In her was youth, beauty, with humble aport,
Bounty, richess, and womanly feature,
God better wot than my pen can report:
Wisdom, largess, estate, and cunning sure,
In every point so guided her measure,
In word, in deed, in shape, in countenance,
That Nature might no more her child advance."

The captive finding that to look on freedom did him good—the sudden rush of the blood to the heart, after it has "abate," stopped for a moment from surprise—the willing thraldom of the heart that gives itself up to that gentle presence,—are touches that betoken the true poet.

A few lines from *Christ's Kirk of the Green* will show (if these poems be by James I., of which there is little doubt) that the royal author possessed wit and humour, as well as fancy and grace, and could write in very different styles. The lines are chosen from the first verses of the poem:—

"Was never in Scotland heard nor seen
Sic dancing nor deray,
Neither at Falkland on the Green
Nor Peebliss at the Play,
As was of wooers, as I ween,
At Christ's Kirk on ane day;
There came our Kittys washen clean
In their new kirtles of gray,
Full gay,
At Christ's Kirk on the Green that day.

PECCARY. ANT EATER. GUINEA-PIG.

"To dance thir damsellis them dight—
Their lasses light of laits (behaviour)—
Their gloves were of the raffel right (roe-fell or deer-skin),
Their shoon were of the Straits (from Morocco; Straits of Gibraltar),
Their kirtles were of Lincoln light
Weel piest with many plaits.
They were so nice, when men them nicht (come nigh)—
They squealit like ony gaits (goats)—
Sa loud,
At Christ's Kirk on the Green that day.

"Of all thir maidens mild as mead
Was nane so jimp as Gillie,
As ony rose her rood was red,
Her lyre was like the lily,
Fu' yellow, yellow was her head,
But she of love was silly;
Though all her kin had sworn her dead
She would have but sweet Willie,
Alane,
At Christ's Kirk on the Green that day."

ZOOLOGY.

XXIII.

The Manatee and Dugong.

Yet another group of mammals has to be noticed which is especially aquatic in its habits. Although but two kinds now remain, they are but the representatives of many more that formerly existed, and it is probable that their nearest relatives are among the hoofed quadrupeds. Although in some respects they resemble the whales, these are merely qualities dependent upon their inhabiting the same medium. The ancient idea of the mermaids and sirens depends upon these creatures, which, when half raised out of the water, present, especially the females, a slight reminder of the human form; when a young dugong is at the same time held to the breast of its mother, the similitude is heightened.

The sirens.

A great horizontal fin encloses the tail; there are no hind-limbs; while the fore-limbs, mainly flipper-like, are more completely organised than those of whales. In one feature, their diet, they are completely contrasted with the latter group, for they feed upon sea-weeds and water-plants, and indeed have been called sea-cows. All their bones are very solid; the skull, it may also be observed, is much smaller in proportion than in any cetacean.

Limbs and diet.

BEAVER.

The Manatee dwells on the west coast of Africa and the east coast of South America, also reaching Jamaica and Florida; but it extends far upwards into each continent, in the great rivers and their large tributaries. How far the species in each locality are distinct is not quite certain; but all manatees are strikingly alike. They may attain a length of a dozen feet. The palate and tongue are covered with a horny pad, admirably suited for rubbing down its rough diet. Eleven grinders appear above and below on each side, and their ridges present a considerable resemblance to those of many of the Ungulates. They have no incisors or canines when adult; but two small incisors are formed in each jaw in early life, and never appear above the jaw. These unused organs seem only to show a descent from some ancestor in which they were protruded above the jaw.

Distribution of manatees.

Horny pads and teeth.

The Dugong has an extensive distribution, though in diminishing numbers, over the coasts bordering the Indian Ocean, along the coasts of Australia, and even to the west coast of Peru. They feed more exclusively upon sea-weeds than the manatees. The females show striking maternal affection.

Rodents or Gnawing Animals.

This order includes more genera and species than any other mammalian order; but squirrels, beavers, mice, rats, lemmings, jerboas, porcupines, guinea-pigs, hares and rabbits, are all united by one remarkable character—that of having a pair of permanently growing incisor teeth in the front of both jaws. In all but the hares and rabbits, the coating of enamel is developed only on the front surfaces of the teeth, the softer dentine being behind. The teeth, meeting, thus wear away into a sharp chisel-shape, and are exquisitely fitted for gnawing all kinds of vegetable products. They are to a large extent vegetable-feeders, although mice and rats, as is well known, are more varied in their diet.

Gnawing teeth.

Many rodents are small, and they have limbs modified for varied habits,—for life in trees, on the ground, under it, and progression in water. Though they are clever in gaining their objects, their brains are small and little complicated. There are usually five clawed toes on each foot, reduced to four or three in the hind-limbs of some. Speed and agility are often provided for by increased length of the hind-limbs and great power in the muscles moving them.

Limbs.

Hares and Rabbits abound in the northern hemisphere, and some species are found in India, South Africa, and South America. They have a second pair of small incisors directly behind the front large pair. The swiftness and timidity of these "small deer," and their power of doubling upon their pursuers, are familiar topics. The hare lives in a shallow pit or "form"; the rabbit makes a hollow or burrow, by preference in sandy soil.

Hares and rabbits.

Over 300 species constitute the great Mouse family, including besides the rats and mice, the Hamsters, courageous creatures which have cheek-pouches in which to accumulate their spoil, Voles, commonly called water and field rats, and the Arctic Lemmings, which make remarkable journeys in countless myriads, traversing mountains, rivers, lakes, and after committing great devastation in harvest fields, finally reach the sea and perish in it. Nearly all the family have but three grinding teeth on each side in both jaws,—a number much less than that of the hares and

Rats and mice.

Lemmings.

rabbits. They have a peculiar long tail, covered with scale-like rings of epidermis. They are found everywhere except in some oceanic islands. Their ferocity, voracity, and burrowing powers can hardly be exaggerated.

The Mole-rats have no tail to speak of, and are specially adapted in legs and feet for digging; their eyes are minute, their gnawing teeth broad and strong; they are entirely vegetarian, and make very extensive burrows in search of roots.

Mole-rats.

The Squirrel is a type of tree-climbers and nut-eaters of small size, charming by its grace and agility, and noted for its bushy tail. It has sharp claws by which it holds to the tree-trunks in its rapid movements. Its food is not restricted to nuts, but extends to leaf buds and birds' eggs. In winter, like many of its allies, it lies hidden and quiescent, being prepared for its rest by the autumn's fattening, and by stores which it lays up for various occasions of hunger.

The squirrel.

Flying squirrels. The flying squirrels have a fold of the skin on each side of the body which can be stretched, and can give the animal considerable support when it leaps from bough to bough.

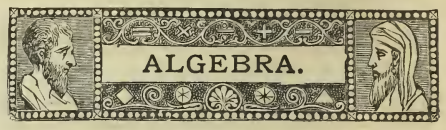
Beavers are now comparatively rare in Europe, more abundant in Northern Asia, and most numerous in North America. They are large and stoutly made, about thirty inches long, with a powerful tail about one-third that length. They are especially adapted for swimming, having their hind-feet webbed; their diet largely consists of the bark of trees, which they cut down systematically with their powerful incisors, using the trunks and branches in suitable lengths for constructing their abodes on the river banks, and for making elaborate dams, by which human reservoirs were anticipated. Their canals, excavated through the low lands bordering their ponds for the purpose of reaching hard wood, and affording a channel for its transportation to their lodges, are evidences of very high intelligence, as also is the construction of secondary dams across a stream, higher up than the main dam, having the effect of diminishing the force of floods when they occur. Their dwellings are plastered with clay, lined with leaves, mosses, etc., and made thoroughly water-tight, with openings always under water.

The beaver.

Beaver dams.

The Porcupine is a remarkable instance of the extent of modification which hairs can undergo: here they take the form of long hard tubes or quills, as well as strong bristles. Being as perfectly under control of muscles as ordinary hairs, they can be elevated at will, and become formidable weapons or protective agents; and as they extend from a foot to sixteen inches in length, they give the creature a very fear-inspiring aspect. Southern Europe and Northern Africa are the abodes of the common porcupine, and other species occur in Asia and Africa; another allied series, the tree-porcupines, belong to the American continent. These latter have prehensile tails and short blunt spines in the midst of long hair.

The porcupine.



IX.

Simultaneous Simple Equations.

If we have one equation containing more than one unknown quantity, we can only find the relation between the values of the unknown quantities; or, as it is called, find the value of one in terms of the other. Thus let the equation be $3x + 2y = 32$, where x and y are both unknown quantities. We can find the value of x thus:

$$3x = 32 - 2y$$
$$x = \frac{32 - 2y}{3};$$

and the value of y:

$$2y = 32 - 3x$$
$$y = \frac{32 - 3x}{2}.$$

But we have got only the relation between the values of x and y; and we cannot find the actual value of either unless we have some independent means of finding the value of the other. For many values of x and y will satisfy the results which we have obtained. In fact, we may give any value we like to either of the unknown quantities, and then determine the *corresponding* value of the other. Thus to take the expression for the value of x, viz.:

$x = \frac{32 - 2y}{3}$, and let us give y the value 1;

then we have:

$$x = \frac{32 - 2}{3} = \frac{30}{3} = 10.$$

Again, let us give y another value, say $y = 4$, then

$$x = \frac{32 - 8}{3} = \frac{24}{3} = 8.$$

Again, suppose $y = 10$, then

$$x = \frac{32 - 20}{3} = \frac{12}{3} = 4.$$

It is clear that we can find as many pairs of values for x and y as we please, if we know nothing more about them than that $3x + 2y = 32$. But the moment we know the value of one of the unknowns, the value of the other can be determined.

Suppose, now, that besides knowing that $3x + 2y = 32$, we also know that $x = 2y$, it is clear that none of the pairs of values found already for x and y will do except the pair $x = 8$, $y = 4$, because no other pair will satisfy the condition $x = 2y$. It won't do to say let $y = 1$, because we know from the first equation that if $y = 1$, x must $= 10$, but 10 is not $= 2 \times 1$, and thus the second equation is not satisfied. The values of x and y are now fixed. We know not merely the relation between them, but the actual value of each.

Thus we see that to determine the values of two unknown quantities, we require to know two independent facts about their relation to

each other, constituting two independent equations. These equations are called *simultaneous* equations, because they must both be true at the same time. Independent equations are equations not deducible from each other. Thus $x+2y=11$ and $2x+4y=22$ are not independent, the second being deduced from the first by multiplying it by 2.

Let it be required to find the values of x and y, which will satisfy the simultaneous equations—

$$2x+3y=23$$
$$5x-2y=10.$$

We may, of course, multiply either or both equations by any numbers we please.

Now, if we multiply the first equation by 2 and the second by 3, we shall get two new equations, in both of which the coefficient of $-y$ has the same numerical value, viz. 6.

These equations are $4x+6y=46$,
and $15x-6y=30$.

It is clear that if we add these new equations one to the other, y will disappear from the resulting equation, or be "eliminated," and we shall get

$$19x=76,$$
$$\therefore x=4.$$

Substitute this value of x in, say, the first equation, and we get, since $x=4$ and therefore $4x=16$,

$$16+6y=46$$
$$6y=30$$
$$\therefore y=5;$$

and we have found the required values of x and y.

To solve the equations—

I. $7x+5y=60.$
II. $5x+2y=35.$

Multiplying I. by 5, and II. by 7, we get—

$$35x+25y=300$$
$$35x+14y=245.$$

To eliminate x we must subtract, and we get—

$$11y=55$$
$$\therefore y=5.$$

Substitute this value of y in II., and we get—

$$5x+10=35$$
$$5x=35-10=25$$
$$\therefore x=5.$$

The student will notice that when the unknown quantity which we are going to eliminate has the same sign in each equation, the one equation must be subtracted from the other; when the unknown quantity has unlike signs in each equation, the equations must be added. We may of course subtract the first equation from the second, or the second from the first; and we may substitute in either equation the value found for the one unknown quantity. In both cases we adopt the course which seems likely to give rise to least labour.

The process employed in the preceding examples is equivalent to the following:—

Rule.—Treat each equation so as to make the coefficient of one unknown quantity in one equation the same as the coefficient of the same unknown quantity in the other equation; by addition or subtraction of the two equations form an equation containing only the other unknown quantity. Solve this resulting equation. In one of the original equations substitute for the one unknown quantity the value which we have just found for it, and solve for the other unknown quantity.

The second method which we may use for solving simultaneous equations is called the method of substitution.

Rule.—Find from one equation the value of one of the unknown quantities in terms of the other; and substitute this value instead of the quantity itself in the other equation. We have thus an equation with one unknown quantity. Solve this equation; and find the value of the other unknown by substitution. Thus, to take our last example but one—

$$\left.\begin{array}{l}\text{I. } 2x+3y=23\\ \text{II. } 5x-2y=10\end{array}\right\}.$$

From the second equation we find—

$$5x=10+2y$$
$$\therefore x=2+\frac{2y}{5}.$$

Substitute this in I., and we get—

$$2\left(2+\frac{2y}{5}\right)+3y=23$$
$$\text{or } 4+\frac{4y}{5}+3y=23.$$

Clearing of fractions—

$$20+4y+15y=115$$
$$19y=95$$
$$\therefore y=5.$$

We found $x=2+\frac{2y}{5}$. Therefore, substituting for y its value,

$$x=2+\frac{2\times 5}{5}$$
$$=2+2=4.$$

The third method of solving simultaneous equations is that by finding from each equation the value of the same unknown in terms of the other. Thus, taking our last example—

I. $2x+3y=23$
II. $5x-2y=10.$

From I.:

$$2x=23-3y$$
$$x=\frac{23-3y}{2}.$$

From II.:

$$5x=10+2y$$
$$x=\frac{10+2y}{5}.$$

We have thus found two different expressions for the value of x. Equate these, and we have an equation containing y only,—thus:

$$\frac{23-3y}{2}=\frac{10+2y}{5}.$$

Clearing of fractions:

$$115-15y=20+4y$$
$$-15y-4y=20-115$$
$$19y=95$$
$$\therefore y=5.$$

Find the value of x as before.

Though the second and third methods are occasionally of great use, and do sometimes save much trouble, the first method is the most convenient in the majority of cases.

LII.

The Time of William III. and of Queen Anne.

The chief feature of the reign of William III. was the increased power of the commons, partly through the conditions under which the crown of England had been bestowed upon the king and his consort, and partly through the greater dependence of the monarch on parliament. In the greater frequency of the meeting of the two houses, the non-recurrence of those long intervals between the dissolution of one parliament and the meeting of the next, and in the importance of the acts passed, we at once recognise the change from a half despotic to a thoroughly constitutional form of rule in England. No fewer than seventeen times did the parliament meet during the thirteen years of William's reign.

Constitutional government.

The time may be considered as a glorious and prosperous one, and contrasts happily with the period of Charles II. and James II. by which it was preceded. The task the king had to perform was one of exceeding difficulty, and required a great amount of sagacity and self-control for its proper fulfilment. William's great object was to establish freedom and the Protestant religion, and to counteract the despotism in church and state that formed the principle of the rule of Louis XIV., whom he considered, with great justice, the dangerous enemy of progress in Europe. Thus nearly the whole of his reign was occupied by a struggle against the French king; first in Ireland, where the contest, though nominally carried on for James, was virtually maintained by the French king's money and soldiers,—for there were 10,000 French fighting under James's banners at the Boyne—afterwards, during the long contest in Flanders, where William, though he gained no great victory in the field, and indeed was several times severely defeated, maintained the strife until the general exhaustion, and the necessity of peace in view of the arrangements to be made by Europe for the Spanish succession, led to the treaty of Ryswick in 1697; and finally in the preparations, amid which the king died, for that still greater contest which occupied the whole of the next reign.

Enmity between William and Louis XIV.

MEDAL OF WILLIAM III. AND MARY.

It was William's aspiration to rule, not as the head of a faction, but as the king of a great and free people. Thus he met with the most violent and persistent opposition. Those who had invited him over—the heads of the Whig party—expected to engross to themselves all the emoluments and offices of the kingdom, and were bitterly angry when they found the king took another view of his duties. The old Tories, on the other hand, whom William tried to conciliate by admitting them to a share of the substantial favours the government had to bestow, looked upon him as partly an enemy even while they accepted his benefits, and plotted against him without compunction. Correspondences were maintained with the exiled king at St. Germains, and intelligence sent over which enabled the enemy to frustrate William's best-laid plans, the intelligence being often given by those to whom the carrying out of those plans was entrusted. Thus Marlborough was dismissed from his employments in 1692 on the clearest proof that he was playing this double game, intriguing with James while he affected to serve William. The difficulties of the king were increased by the fact of his being a foreigner; while his cold, imperturbable, and somewhat distant manner offended the English nobles, who had been accustomed to something like friendly and familiar intercourse with their kings. The hardly disguised jealousy of his foreign dominion, and the fear openly expressed that he would subordinate the interests of England to those of his native country, contributed to render his residence in England distasteful to William. Indeed, he was more than once strongly tempted to resign his authority in England altogether, and it was probably owing to the persuasion of Somers that he did not carry out his idea. To escape from Whitehall, Hampton Court, or St. James's, and solace himself with a hunting expedition on his Dutch domain of Loo, was his greatest pleasure. The unamiable parts of his character were on the surface, while his great qualities were not understood or appreciated until after his death. The blame of some evil actions, such as the massacre of Glencoe, and of intrigues such as those which destroyed the hopeful Darien scheme, has been cast upon him, where his approval seems to have been given under a misapprehension; but the judgment of a later

Difficulties of his position.

Errors in government.

time has given him the credit of being a great, wise, and thoroughly honest king.

War with France.

The nation, as represented by the parliament, supported the king liberally in his war against Louis XIV., justly appreciating the magnitude of the issues at stake. In 1690 a sum of three millions and a half sterling was voted for warlike purposes: £2,500,000 for the army and £800,000 for the navy. At first there was much treachery at work—men wore their political creed very loosely in those days—and traitors were to be found even in the highest ranks and in foremost offices. Thus an expedition against Brest, carefully planned by the king, and the secret of which was entrusted only to his ministers, completely failed, the particulars having been communicated to Louis within a few days; and for the last time in English history the British flag at sea was disgraced, through the equivocal conduct of those in command of the fleet. But this disgrace was quickly retrieved by the valour of Admiral Rooke, who gained a splendid victory off La Hogue, May 19th, 1692. It is told that James, witnessing the defeat of his allies, could not refrain from expressions of admiration at the valour of "his gallant English sailors." An expression of his father's in 1642, "Have those water-rats turned against me?" would seem more in consonance with his character. James was hardly the man to appreciate valour employed against himself. The foundation of Greenwich Hospital, on the domain of an old royal palace, by Queen Mary, was the reward of the gallantry of the English sailors.

The Navy;—La Hogue.

On land the success was at first with Louis, who took Namur, which fortress William, to his bitter mortification, was unable to relieve; nor was he more successful in his attempt to surprise the great French general Marshal Luxembourg, at Steinkirk, in July 1692. He inflicted, indeed, a severe loss on the French, but failed in his purpose of routing the Marshal, after sacrificing 7000 of his own men. In the following year Luxembourg again had the advantage, at Neerwinden or Landen, each side losing about 30,000 men; but William was indomitable, and drew off his men in such good order that the enemy profited little by the sanguinary victory. After Luxembourg's death the tide began to turn in William's favour, for September 1695 saw him master of Namur. In the next year the French king made overtures for peace, and the following year saw the signing of the treaty of Ryswick, by which Louis formally acknowledged William as king of England; whereupon the parliament, jealous of the king's influence, reduced the standing army to 10,000 men.

Namur and Steinkirk.

Treaty of Ryswick.

THE EMBARKATION OF WILLIAM OF ORANGE AT HELVOETSLUYS FOR TORBAY.

The other warlike event of importance in this reign was the prompt despatch of the British fleet under Rooke into the Baltic, to prevent the ruin of the Swedish monarchy by the confederate powers of Denmark, Russia, and Saxony. The great war of the Spanish succession, amid the preparations for which William died, belongs to the following reign.

Great and weighty political measures mark the reign of this king. Besides the all-important Bill of Rights, there are to be chronicled the Mutiny Act, placing the army under martial law, and now renewed annually by parliament; the Toleration Act, "exempting their Majesties' Protestant subjects dissenting from the Church of England from the penalties of

Political measures of the reign.

certain laws," relieving Protestant dissenters, but not the Romanists, whose position indeed was made considerably worse by the Bill for further preventing the growth of Popery, passed in 1699, and maintained till 1778, when its partial repeal gave rise to the discontent that ultimately found expression in the Gordon Riots of 1780; the establishment of the liberty of the press, the law against unlicensed printing being abolished; and the Act abolishing the obnoxious hearth tax, which had been a fertile source of discontent and sedition.

The establishment, under royal charter, of the Bank of England in 1694, and the incorporation of a new East India Company—the condition in each case being the lending of a large sum of money to the government for the prosecution of the French war—are other important events. Now also the civil list was settled, the money paid to the king for his private expenses being separated from the sums paid into the national exchequer for public purposes, such as the carrying on of war, etc.

Of the various plots and conspiracies by which the reign was disturbed, the most important was that for the assassination of the king, originated by Sir John Fenwick, and for which that person, with several of his confederates, was executed, in pursuance of an attainder—the last time, in our history, such an instrument was employed.

Plots and conspiracies.

To the great grief of William, his consort Mary, the truest and most affectionate of wives, died in 1692, at the age of thirty-two. William cherished her memory to the latest moment of his life, and after his death her miniature with a lock of her hair was found concealed on his heart. His own death happened in consequence of an accident while hunting near Hampton Court. He broke his collar-bone; fever set in; and his constitution, already worn out "by sickness and by care," could not withstand the shock. He had attained his fifty-second year.

LIII.

Exercise on the Studies on "Frederick the Great,"

For Translation into German.

(N.B.—Note the forms of the irregular verbs used in this exercise.)

Frederick the Great rode often through the streets of Berlin, and in the neighbourhood of his palace at Potsdam. He drove very seldom, for he thought that a soldier should not sit in a carriage. Only at the time of the carnival he was accustomed, while he resided (sich aufhalten) in Berlin, to appear in a carriage. He drove then at a slow pace; before his carriage went runners (onward). These were generally pensioners from the guard. The king always drove through the same streets, for his errands (ways) were always the same; from the palace to the opera, or to visit Prince Henry or the Princess Amelia. The royal liveries were blue, with red cloth at the seams, collars and pockets. A great mass of people came always to see the king drive by. The Berliners formed a line on both sides; and looked at the great monarch with respect, and in silence.

When the king held (a) review near Berlin, he was accustomed to ride a great white horse, which was called (the) old Condé, and that was a great favourite. Behind him came a great number of officers, generals, adjutants, and others. All windows were occupied by people who sat there to see the king ride past. All heads were bare from respect to the king, who was looked upon as the protector and friend of the people. Frederick returned the greeting of his subjects by continually taking off his hat. According as the rank or position of the spectators who saluted him deserved it, the king either lifted his hat a little from his head, or took it entirely off. Sometimes he held the hat for a time in his hand. Scarcely had he then put on the hat again, when he saw other acquaintances, and took it off anew. The Berlin street-boys, who loved the king much, and looked upon him as their old friend, danced along beside the procession, came close to the king, stroked his horse, and wiped the dust for him from his (the) boots. The king, who was quite accustomed to this, let them do what they would; only when the noise became too bad, he sometimes lifted his stick, and called threateningly, "Will you, boys?" But as no deed followed upon these threatening words, the boys continued to jump and to shout around him; for they knew that their old Fritz would do nothing to them. So they threw their hats in the air, and rejoiced; and thus, under the eyes of the whole city, moved (itself) the strange procession through the streets of Berlin.

The great king continued at certain times to ride thus, until almost the end of his long life, which closed in the year 1786, when Frederick had attained an age of seventy-four years.

German Version for Re-translation and Repetition.

Friedrich der Große ritt oft durch die Straßen Berlin's, und in der Nachbarſchaft ſeines Schloßes zu Potsdam. Er fuhr ſehr ſelten; denn er dachte daß ein Soldat nicht in einem Wagen ſitzen ſollte. Nur zur Zeit des Carnevals pflegte er (war er gewohnt) während er ſich in Berlin aufhielt, in einem Wagen zu erſcheinen. Er führ dann im langſamen Schritt; vor ſeinem Wagen gingen Läufer einher. Dieſe waren Jewöhnlich Invaliden, aus der Garde. Der König fuhr immer durch dieſelben Straßen, denn ſeine Wege waren immer dieſelben;—von Schloße in die Oper, oder den Prinzen Heinrich oder die Prinzeſſin Amalia zu beſuchen. Die Königlichen Livreen waren blau mit rothem Tuch an den Näthen, Kragen,

und Taschen. Eine große Masse von Menschen kam immer den König vorbei fahren zu sehen. Die Berliner bildeten eine Gaße zu beiden Seiten; und blickten den großen Monarchen mit Ehrfurcht und schweigend an.

Wann der König eine Revue (Heerschau) bei Berlin hielt, pflegte er ein großes weißes Pferd zu reiten, welches „der alte Condé," hieß, und ein großer Liebling war. Hinter ihm kamen eine große Menge Offiziere, Generale, Adjutanten, und andere. Alle Fenster waren von Menschen besetzt, die daßaßen, den König vorbeireiten zu sehen. Alle Häupter waren entblößt, aus Ehrfurcht gegen den König, der als der beschützer und Freund des Volkes angesehen wurde. Friedrich erwiederte den Gruß seiner Unterthanen, indem er fortwahrend den Hut abnahm. Je nach dem der Rang oder die Stellung der Zuschauer die ihn grüßten es verdiente, lüftete der Konig den Hut ein Wenig von dem Kopfe, oder nahm ihn ganz ab. Manchmal hielt er den Hut eine Zeit lang in der Hand. Kamm hatte er den Hut wieder aufgesetzt, als er andere Bekannte sah, und ihn von neuem abnahm. Die Berliner Straßen jungen, die den König sehr liebten, und ihn als ihren alten Freund ansahen, tanzten neben dem Zuge her, kamen dicht an den König heran, und wischten ihm den Staub von den Strefeln ab. Der König der ganz daran gewohnt war, ließ sie thun was sie wollten; nur wann der Lärm zu argwurde, erhob er manchmal den Stock, und rief drohend: „Wollt ihr, Jungens?" Aber da keine That auf diese drohenden Worte folgte führen die Knaben fort um ihn herum zu springen und zu schreien; denn sie wußten daß ihr alter Fritz ihnen nichts thun würde. So wasfen sie die Hüte in die Luft, und gauchten; und also, unter den Augen der ganzen Stadt, bewegte sich der sonderbare Zug durch die Straßen Berlins.

Der große König fuhr fort, zu gewissen Zeiten also zu reiten, beinahe bis an das Ende seines langen Lebens, welches in dem Jahre siebenzehn hundert sechs und achtzig schloß, als Friedrich ein Alter von vier und siebenzig Jahren erreicht hatte.

Study on the Intransitive Verbs.

Intransitive verbs are those in which the action or the state described does not pass over (*transire*) to an object—such as sitzen, to sit; stehen, to stand; klagen, to complain. Many are followed by an accusative case, expressing, in the case of those denoting a state, the time during which the state lasts—as Ich habe den ganzen Tag gewartet, I have waited (during) the whole day; and in those verbs denoting an action, the instrument or manner of the action is placed in the accusative. Thus—Mein Vetter ritt den Schecken an dem Tag, My cousin rode the piebald on that day (Schiller's *Wallenstein*); Er konnte drei sprachen reden, He could speak three languages. In general those verbs which though intransitive express an action—such as stehen, to stand, gefallen, to be pleasing, schlafen, to sleep, are considered as doing something, and are therefore conjugated with haben; while sterben, to die, is considered as suffering something, and is accordingly conjugated with seyn: Er ist am vorigen Montag gestorben, he died last Monday. But some verbs expressing in this sense an action are nevertheless conjugated with seyn—such as folgen, to follow (folgen, conjugated with haben, meaning *to obey*); kommen, to come (like the French *venir, je suis venu*, ich bin gekommen); bleiben, to remain, etc. Some are conjugated with both haben and seyn, according to the sense in which they are taken: Der Mann hat gesprungen, the man has sprung (general assertion with haben); der Mann ist von der Brücke gesprungen, the man has sprung from the bridge (special, with mention of locality, time, etc., with seyn).

X.

Light (*continued*).

A simple piece of apparatus may be easily constructed by the reader which will very conclusively prove the law of reflexion laid down in our last article (p. 789). This simple piece of apparatus is represented in fig. 47. **Experimental proof of the law of reflexion.**

A A may be either a semicircular piece of wood or a similarly-shaped piece of cardboard. Round

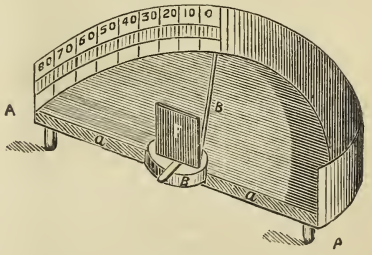


FIG. 47.

this a piece of metal or cardboard is placed, as shown in the figure, and this has marked upon it a graduated scale, and has also a vertical slit at *a*. A rod, B, is made to rotate upon a vertical axis, and upon this is fixed vertically a small mirror, F. Small mirrors for this and similar purposes may be easily made by covering one side of a small microscopic cover glass with quicksilver, and then placing it for a few hours under a very heavy weight, interposing a piece of blotting-paper between the latter and the mercury. When the apparatus is complete, the rays of

light passing through the slit *a* will be seen to be reflected at any angle equal to that made by the incident ray; thus, if the pointer, B, be placed at 10° the reflected ray will appear at 20°, and so on. If the pointer be placed at 0°, the ray will of course be reflected back upon itself.

Mirrors.

Every polished surface which reflects regularly the rays of light which fall upon it is in optics termed a "mirror." Mirrors are usually polished surfaces of either metal or glass, but *any* surface which reflects regularly constitutes a mirror. The best mirror is Nature's own—the smooth, still surface of a sheet of water. Mirrors are of three kinds: *plane*, such as our ordinary looking-glasses; *concave*, or hollow, like the inside of a watch-glass; *convex*, like the outside of a watch-glass. There are also used for optical purposes *parabolic* mirrors, which are segments, not like concave or convex mirrors of a *sphere*, but of a *parabola*.

Reflexion by plane mirrors.

As is known to every one, plane mirrors reflect the rays which fall upon them with startling fidelity, producing the most accurate images of objects placed before them; and as every one must have noticed who has ever gazed upon "the human form divine" in a looking-glass, the image appears to be as far behind the mirror as the object is in front of it. The explanation of this fact will be easily grasped upon reference to fig. 48. Here AN and AP represent two out of a number of rays thrown by the luminous point A upon the mirror S S′. According to the law of reflexion these will be reflected in the direction *n o p q*, and if these latter rays be produced backwards they will meet each other at *a*, and this point can be shown to be in a straight line with the luminous point, A, and as far behind the mirror as

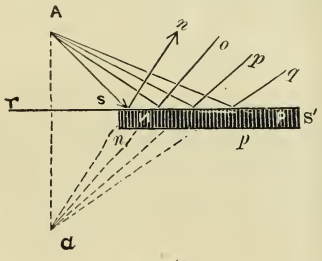


FIG. 48.

the latter is in front of it. An observer in front of the mirror would perceive the rays as if they came from *a*, and would therefore see *in*, or apparently *behind* the mirror, the image of the point A, as far behind the mirror as A is really in front of it, the brain perceiving the rays of light in the direction in which they enter the eye, such images being termed virtual, as distinguished from real, images, to be described hereafter.

The images formed by a plane mirror, although they exactly correspond in size and position with the objects, are not exactly the same in every respect; they undergo what is known as *lateral inversion*—that is to say, the right side of the object is the left in the image, and *vice versâ*; hence a person standing before a mirror and having his hair parted on the left side, his image would appear to have its hair parted on the right side. This phenomenon may be understood by a little consideration of the law of reflexion as explained above.

Lateral inversion.

As the reflected rays of light travel as if they came from the back of the mirror, they will be again reflected if they fall upon a second reflecting surface; these again may be reflected by another, and so on indefinitely; hence it is possible to produce a number of images with two mirrors, and the reader may for himself devise some such most interesting and amusing experiments. If the mirrors are exactly parallel, as in fig. 49, a number of images of a point O, placed between them, will be seen ranged in a line, and, inasmuch as some light is lost at every reflexion, the successive

Reflexion from mirrors

Light

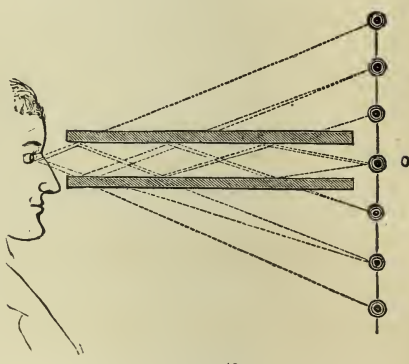


FIG. 49.

images become fainter and fainter. If the mirrors be placed at an angle the number of images produced is always one less than the number obtained by dividing 360° by the degrees in the angle; thus if the two mirrors are placed at an angle of 60° the number of images formed will be five, or if the object itself be counted as one, six; these images, as is always the case when two mirrors are inclined at an angle, will be arranged on the circumference of a circle.

The kaleidoscope.

That entertaining and instructive toy, the kaleidoscope, which was invented by Sir David Brewster, depends upon this principle for its construction. In a long cardboard or metal tube two long strips of glass, silvered on the back, are placed at an angle of 60°. At one end of the tube is a glass box, the outer plate of which is of ground glass, containing small pieces of coloured glass, etc. At the other end of the tube is a small hole for the eye of the observer. Upon turning the tube round, ever-changing and often strikingly beautiful combinations are formed by the repeated reflexions of the images of the fragments of glass.

A sheet of good plate-glass not only allows

rays of light to pass through it, but also reflects them from its anterior surface. If, as in fig. 50, a water-bottle be placed behind a sheet of glass, and a lighted candle in front, the latter will be reflected, and the curious phenomenon of a lighted candle burning in a bottle of water will be apparent to an observer. This is the principle of the favourite "ghost illusion." The

Principle of the ghost illusion.

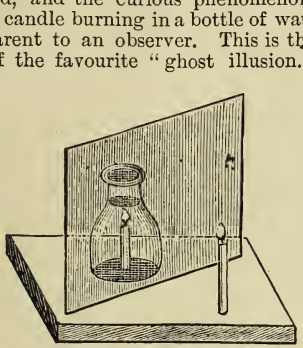


FIG. 50.

back part of the stage is closed by means of a large plate of spotlessly clean and clear plate-glass, which is slightly inclined forwards. Through this the players, who are only feebly illuminated, are seen by the audience. Below and in front of the stage are the persons who are to represent the "ghosts," and their images strongly illuminated are reflected by the glass and appear upon the stage.

XLIV.

THE VERB (*continued*).—THEORY.

1. THE VARIOUS CLASSES OF VERBS (*continued*).—Certain verbs, in becoming pronominal, do not merely adopt an idea of action reflected, or action suffered, but present, in certain phrases, new acceptations of the original sense. Such cases, from the point of view of comparative grammar, require attention. We present here what we believe to be the leading facts.

ATTENDRE, *to wait for:* nous attendons la fin, *we are waiting for the end.*—s'attendre à, *to expect:* nous nous attendions à cette fin, *we were expecting that end;* je m'y attends, *I expect it.*—s'attendre à quelqu'un, *to rely upon some one:* ne t'attends qu'à toi seul, c'est un commun proverbe (La Fontaine), *rely upon thyself alone, that is a well-known proverb.* [This does not prevent *s'attendre* from meaning also *to wait for one another.*]

AVISER, *to advise, to warn, to perceive, to think:* il l'avisa de faire telle chose, *he advised him to do so-and-so;* je l'avisai dans la foule, *I perceived him in the crowd,* etc.—s'aviser, *to bethink oneself, to take into one's head:* on ne s'avise jamais de tout, *one never bethinks oneself of everything;* de quoi s'avise-t-elle? *what is she taking into her head?*

BATTRE, *to beat:* nos soldats ont battu l'ennemi, *our soldiers have beaten the enemy.*—se battre, *to fight:* les vôtres se sont bien battus, *yours have fought well;* se battre à coups de poing, *to box.*

CONFESSER, *to confess:* ils confessèrent tous leurs crimes, *they confessed all their crimes.*—se confesser (absolutely used), *to attend the rite of confession:* ils venaient de se confesser, *they had just been attending confession.* [The strictly original meaning reappears with a qualification: il se confesse vaincu, notre débiteur, *he confesses himself beaten, our debtor.*]

DÉFIER, *to challenge, to brave:* je vous défie aux échecs, *I challenge you to a game at chess.*—se défier, *to mistrust:* elle se défiait de son propre cœur, *she was mistrusting her own heart;* nous nous en défions, *we mistrust it.* [Also *ils se défient* = they challenge each other.]

DOUTER, *to doubt:* il doute de tout, *he doubts everything.*—se douter, *to guess:* on se douta du tour, *people guessed the trick;* je m'en doutais bien, *I was guessing as much.*

EMBALLER, *to pack, to bundle off:* emballez vos meubles, *pack your furniture.*—s'emballer, *to bolt:* le cheval s'emballe, *the horse bolts;* also *to allow one's passion or folly to get the better of one:* comme il s'emballe, *what a fool he is making of himself* (the French version being as familiar as the English).

FAIRE, *to do, to make.*—se faire à, *to become accustomed to:* on se fait à tout, *one becomes accustomed to everything;* also *to form oneself, to ripen:* c'est un jeune homme qui se fera, *it is a young man who will form himself;* ce fromage s'est fait, *this cheese has ripened.* [But *se faire* has also a passive sense: *cela se fait* = that is done; it is likewise used impersonally—*il se fait des choses pareilles tous les jours,* every day similar things happen.]

JOUER, *to play:* ne jouez pas avec les armes à feu, *do not play with firearms;* ils jouent aux cartes, *they are playing cards.*—se jouer, *to overcome lightly, to mock:* ces hommes robustes se jouent des travaux les plus rudes, *those robust men overcome lightly the hardest labours;* il ne faut pas se jouer ainsi des lois, *laws must not be mocked so.* [The reflective form is also used intransitively with the original meaning of the verb: *cet enfant se joue avec tout ce qu'on lui donne,* this child plays with everything that is given to it; *les oiseaux se jouent dans le feuillage,* the birds are playing in the leaves.]

MARIER, *to unite people in matrimony, or to bring about a marriage:* le maire nous mariera, *the mayor* (in his capacity of registrar) *will marry us;* elle a marié sa fille fort avantageusement, *she has found a good match for her daughter.*—se marier, *to marry:* elle s'est mariée à Pâques, *she married at Easter;* ils se marieront en juin, *they will marry,* or *will be married, in June.*

METTRE, *to put:*—se mettre à (*followed by an infinitive*), *to begin:* tout le monde se mit à rire, *everybody began to laugh;* se mettre, *to dress;* elle se met fort bien, *she dresses very well.* [The reflective form of the original meaning is also much used: *on se mit à table,* they sat down to dinner; *on se mit à la table,* they put themselves to the table; *il se mit bientôt au fait, et devint à la fin si habile* (P. L. Courier), he soon acquired the special knowledge required, and became at last so expert . . .]

MOURIR, *to die:* tout meurt, *everything dies;* se mourir, *to die away, to long to:* votre lampe se meurt, *your lamp is dying out;* elle se meurt d'impatience, *she is dying with impatience;* nous nous mourons de le revoir, *we long to see them again.*

PASSER, *to pass:*—se passer, *to pass away, to die out:* en marchant cela se passe (Mme de Sévigné), *in walking it passes away;* cette mode se passe, *this fashion is dying out;* se passer, *to come off:* mais dis-nous comment tout s'est passé (Corneille), *but tell us how everything came off;* comment s'est passé votre voyage? *what sort of a journey had you?* se passer de = *to be content with* or *to dispense with:* la sagesse, qui accoutume les hommes à se passer de peu, m'a tenu lieu de tous les autres biens (Fénelon), *wisdom, which accustoms men to be content with little, has compensated me for all other goods;* je puis me passer que vous m'estimiez (J. J. Rousseau), *I can dispense with your esteeming me.* [The pronominal form presents also the reflective and passive views as taken of the original: *il se passa lui-même* (de Retz), he surpassed himself; la moitié de la vie se passe en sommeil, *one half of life is spent in sleep.*]

PIQUER, *to prick, to sting.*—se piquer, *to be piqued at, to get touchy, to stand upon:* entre amis on ne va pas se piquer pour si peu de chose (Molière), *among friends one would not be piqued at such a small matter.*—se piquer de, *to boast, to become moth-eaten, to turn sour:* il se piquait de tout et n'était bon à rien (Marmontel),

he was boasting of being able to do everything, and was fit for nothing; ces étoffes se piquent, *these stuffs are becoming worm-eaten;* cette boisson se pique, *this beverage is turning sour.*

PLAINDRE, *to pity.*—se plaindre, *to complain:* je le plains plus que je ne m'en plains, *I pity him more than I complain of him;* l'amour qui se plaint le plus n'est pas toujours le plus à plaindre (Quinault), *love which complains most is not always the most to be pitied.*

PRENDRE, *to take.*—se prendre à: *to clutch by, to attack, to begin:* un homme qui se noie se prend à tout ce qu'il peut, *a drowning man clutches at a straw* (*at anything he can*); il ne faut pas se prendre à plus haut que soi, *one should not attack a higher man than oneself;* elle baissa la tête, et se prit à pleurer (Delavigne), *she bent her head and began to weep.*—s'en prendre à, *to blame:* je m'en prendrai à vous, *I shall blame you for it.*—s'y prendre, *to set about a thing:* tu ne sais comment t'y prendre, *thou dost not know how to set about it.*

RECLAMER, *to claim, to protest, etc.*—se réclamer de, *to give as a referee, to invoke in one's favour:* s'il vous arrive quelque chose réclamez-vous de moi, *if anything happens to you, give me as your referee;* il se réclama du droit des gens (Ségur), *he invoked international law in his favour.*

SERVIR, *to serve.*—se servir de, *to use:* également capables de se servir de la fortune et de l'attendre (Montesquieu), *as fit to use fortune as to wait for it.*—Je me sers chez cet épicier, *I am dealing with this grocer;* il se sert depuis longtemps de ce tailleur, *he has been employing this tailor for a long time.*

2. IMPERSONAL VERBS.—These are also known under the name of *unipersonal* verbs. They are *impersonal* in sense, as they do not admit of a person as their subject; they are *unipersonal* in form, as they borrow in each tense no other part than that of the 3rd person singular, with the indefinite *il* (it, or there) as a subject. They are either *accidentally* or *essentially* impersonal. For instance, *il arrive*, it happens, is called accidental, because, in another acceptation of the word, one may say *j'arrive, tu arrives*, etc.; and *il grêle*, it hails, is said to be essential, because one uses the forms *je grêle, tu grêles*, etc., in no acceptation whatever.

Some of these verbs are conjugated with *avoir*, others—which we shall mark with an asterisk—take *être;* but none allow any inflexion of their past participle. In other respects they follow the conjugation indicated by their infinitive.

As some of the more intricate idioms are connected with these verbs, we shall dwell more than is generally done in grammars on this subject, beginning with the simpler constructions.

a. Impersonal verbs which have a more or less complete sense in themselves, referring for the most part to natural phenomena :—

bruiner, *to drizzle;* il bruine, *it drizzles* (p. 615, vol. i.)
éclairer, *to lighten;* il éclaire, *it lightens* (do.)
grêler, *to hail;* il grêle, *it hails* (do.)
tonner, *to thunder;* il tonne, *it thunders* (do.)
venter, *to blow;* il vente, *it blows* (do.)
dégeler, *to thaw;* il dégèle, *it thaws* (p. 623, vol. ii.)
geler, *to freeze;* il gèle, *it freezes* (p. 615, vol. i.)
neiger, *to snow;* il neige, *it snows* (p. 510, vol. ii.)
y aller, *to be at stake;* il y va, *is at stake* (see below)
y avoir, *there to be;* il y a, *there is* (do.)
être, *to be;* il est, *there is* (p. 323, vol. i)
faire, *to be* (of the weather); il fait, *it is* (see below)
pleuvoir, *to rain;* il pleut, *it rains* (do.)
valoir mieux, *to be better;* il vaut mieux, *it is better* (see below)

i. Y ALLER, *to be at stake*, has the forms: IND. *Present,* il y va, *is at stake; Imperfect,* il y allait, *was at stake; Perfect* (not often used), il y alla, *was at stake; Future,* il ira, *will be at stake;* COND. *Present,* il irait, *would be at stake;* SUBJ. *Present,* qu'il y aille, *that . . . may be at stake; Imperfect,* qu'il y allât, *that . . . might be at stake.*

[No compound tenses used; disappearance of *y* in Future and Conditional for reason of euphony.—Exs. *Il y va de votre réputation,* your fair name is at stake; *il y allait d'être heureux toute sa vie,* a whole life's happiness was at stake; *comme il ira de sa gloire,* as his glory will be at stake; *quand il irait de ma vie,* though my life were at stake.]

ii. Y AVOIR, *there to be*, is complete in its conjugations :—

INFINITIVE.

Present.	*Past.*
y avoir, *there to be.*	y avoir eu, *there to have been.*

PARTICIPLE.

Present.	*Past.*
y ayant, *there being.*	y ayant eu, *there having been.*

INDICATIVE.

Present.	*Perfect Indefinite.*
il y a, *there is, there are*	il y a eu, *there has* (*or have*) *been*
il n'y a pas, *there is not*	[*not been*
y a-t-il? *is there?*	il n'y a pas eu, *there has*
n'y a-t-il pas? *is there not?*	y a-t-il eu? *has there been?*
	n'y a-t-il pas eu, *has there not been?*
Imperfect.	*Pluperfect.*
il y avait, *there was.*	il y avait eu, *there had been.*
Perfect Definite.	*Perfect Anterior*
il y eut, *there was.*	il y eut eu, *there had been.*
Future Absolute.	*Future Anterior.*
il y aura, *there will be.*	il y aura eu, *there will have been.*

CONDITIONAL.

Present or Future.	*Past.*
il y aurait, *there would be.*	il y aurait eu, *there would have been.*

SUBJUNCTIVE.

Present.	*Perfect Definite.*
qu'il y ait, *that there may be.*	qu'il y ait eu, *that there may have been.*
Imperfect.	*Pluperfect.*
qu'il y eût, *that there might be.*	qu'il y eût eu, *that there might have been.*

[Let the English be *there is* or *there are*, the corresponding French will always remain *il y a*, and so with the other tenses. Exs. *Il n'y a rien qui rafraîchisse le sang comme une bonne action* (La Bruyère), there is nothing to refresh the blood like a good action; *si chacun faisait tout le bien qu'il peut faire sans s'incommoder, il n'y aurait pas de malheureux* (Duclos), if every one did all the good he can do without putting himself to any inconvenience, there would be no unfortunate people.—*N'y eût-il que cette raison, elle devrait vous décider*, even though there should be but this motive, it ought to decide you; *il n'y a pas de quoi fouetter un chat*, the matter is very trivial (there is not *wherefor* to whip a cat); *merci. Il n'y a pas de quoi*, thanks. Don't mention it; *il n'y a rien qui presse*, there is no hurry.—*Il est, il était, il fut*, may be elegantly substituted for the corresponding tenses of *y avoir: il est des hommes que la résistance anime, il en est d'autres qu'elle décourage* (Acad.), there are men whom opposition rouses, there are others whom it damps. This *may* appear in lofty prose, but *must* be used in verse, because *il y a* presents a hiatus, which, pedantically enough to our mind, is condemned by rhetoricians :—

Il *est* dans tout autre art des degrés différents :
On peut avec honneur remplir les seconds rangs;
Mais dans l'art dangereux de rimer et d'écrire,
Il n'*est* point de degrés du médiocre au pire.
(BOILEAU.)

—In any other art there are various degrees, and one may honourably occupy the second place; but in the dangerous art of rhyming and writing there are no degrees between middling and worst—he who is not quite good is bad.]

iii. In connection with *être* observe the following constructions: 1. *S'il en est, s'il en fut*, coming after an epithet, means that it is thoroughly deserved: *un voleur s'il en est, un honnête homme s'il en fut jamais*, as much of a thief, of an honest man, as possible.—2. *Il est en . . . de* = it is in the power of: *il était en Mme de Pompadour d'empêcher la guerre de sept ans*, it was in

the power of Mme de P. to prevent the seven years' war.—3. *Toujours est-il* = it is certain: *il nie avoir reçu cet argent, toujours est-il que depuis quelque temps, il fait de fortes dépenses*, he denies having received that money, yet it is certain that for some time past he has spent much.—4. *Quelle heure est-il? il est midi, il est une heure*, what o'clock is it? it is twelve, it is one o'clock; *à l'heure qu'il est*, at the present time.—5. *Il n'est que de* = the best thing is: *il n'est que de prendre les hommes tels qu'ils sont*, the best thing is to take (nothing like taking) men as they are.—6. *Il n'est que de* = speaking of those things, the best come from: *il n'est de truffes que de Périgord*, the best truffles come from Perigord; *il n'est de cidre que de Normandie*, the best cider comes from Normandy.—7. *Il n'est pas que . . . ne* = it is impossible to suppose that . . .: *il n'est pas que vous ne sachiez quelques nouvelles de cette affaire* (Molière), it is impossible to suppose that you possess not some information about this matter.—*Etre* may form any number almost of impersonal verbs by the addition of some past participle or adjective: *il est acquis*, it is an ascertained fact; *il est défendu*, it is forbidden; *il est permis*, it is lawful, one is allowed, etc.

iv. FAIRE, to be (in speaking of the weather) is fully conjugated: INF.—*Past*, avoir fait, *to have been*. PART.—*Present*, faisant, *being*; *Past*, fait, *been*; ayant fait, *having been*.

IND.—*Present*, il fait, *it is*; *Imperfect*, il faisait, *it was*; *Perfect Definite*, il fit, *it was*; *Future Absolute*, il fera, *it will be*; *Perfect Indefinite*, il a fait, *it has been*; *Pluperfect*, il avait fait, *it had been*; *Perfect Anterior*, il eut fait, *it had been*; *Future Anterior*, il aura fait, *it will have been*.

COND.—*Present*, il ferait, *it would be*; *Past*, il aurait fait, *it would have been*.

SUBJ.—*Present*, qu'il fasse, *that it may be*; *Imperfect*, qu'il fît, *that it might be*; *Perfect Definite*, qu'il ait fait, *that it may have been*; *Pluperfect*, qu'il eût fait, *that it might have been*.

[This verb serves to mark the state of the atmosphere, and, as the examples below will show, receives many applications. By extension one says also: *il fait cher vivre à Paris*, living is dear in Paris; *il fait meilleur chez nous*, there is more comfort with us; *la peste! il y ferait bon, méfiant comme vous êtes* (Beaumarchais), zounds! I would not advise any one to try it, considering how distrustful you are.

quel temps fait-il?	*how is the weather?*
il fait beau temps	*it is fair weather*
„ „ du brouillard	*it is foggy*
„ „ des éclairs	*there is lightning*
il faisait un grand vent	*it was very windy*
il fit une gelée blanche	*there was hoar-frost*
il fera du soleil	*the sun will shine*
il a fait clair de lune	*there was moonshine*
il ferait de l'orage	*there would be a storm*
il fait grand jour	*there is broad daylight*
je crois qu'il fait chaud	*I think it is warm*
je voudrais qu'il fît froid	*I wish it were cold*
les chaleurs qu'il a fait l'année dernière	*the heat there has been last year*
il faisait doux quand nous sommes sortis, etc.	*it was mild when we went out, etc.*

Whereas one says *il fait beau temps*, one could never say *le temps fait beau*; with *le temps* as a nominative the right verb is *est—le temps est beau*.]

v. PLEUVOIR, *to rain*, is an irregular verb, and fully conjugated. INF.—*Past*, avoir plu, *to have rained*. PART.—*Present*, pleuvant, *raining*; *Past*, plu, *rained*; ayant plu, *having rained*.

IND.—*Present*, il pleut, *it rains*; *Imperfect*, il pleuvait, *it was raining*; *Perfect Definite*, il plut, *it rained*; *Future Absolute*, il pleuvra, *it will rain*; *Perfect Indefinite*, il a plu, *it has rained*; *Pluperfect*, il avait plu, *it had rained*; *Perfect Anterior*, il eut plu, *it had rained*; *Future Anterior*, il aura plu, *it will have rained*.

COND.—*Present*, il pleuvrait, *it would rain*; *Past*, il aurait plu, *it would have rained*.

SUBJ.—*Present*, qu'il pleuve, *that it may rain*; *Imperfect*, qu'il plût, *that it might rain*; *Perfect Definite*, qu'il ait plu, *that it may have rained*; *Pluperfect*, qu'il eût plu, *that it might have rained*.

vi. VALOIR MIEUX *to be better*, is an irregular verb which has a complete conjugation. INF.—*Past*, avoir mieux valu, *to have been better*. PART.—*Present*, valant mieux, *being better*; *Past*, mieux valu, *been better*; ayant mieux valu, *having been better*.

IND.—*Present*, il vaut mieux, *it is better*; *Imperfect*, il valait mieux, *it was better*; *Perfect Definite*, il valut mieux, *it was better*; *Future Absolute*, il vaudra mieux, *it will be better*; *Perfect Indefinite*, il a mieux valu, *it has been better*; *Pluperfect*, il avait mieux valu, *it had been better*; *Perfect Anterior*, il eut mieux valu, *it had been better*; *Future Anterior*, il aura mieux valu, *it will have been better*.

COND.—*Present*, il vaudrait mieux, *it would be better*; *Past*, il aurait mieux valu, *it would have been better*.

SUBJ.—*Present*, qu'il vaille mieux, *that it may be better*; *Imperfect*, qu'il valût mieux, *that it might be better*; *Perfect Definite*, qu'il ait mieux valu, *that it may have been better*; *Pluperfect*, qu'il eût mieux valu, *that it might have been better*.

[Exs. *Mais, tyran pour tyran, il vaut mieux vivre à Rome* (Corneille), if we must have a tyrant, it will be preferable to live at Rome; *il leur vaudrait bien mieux, les pauvres animaux, de travailler beaucoup, de manger de même* (Molière), it would be better for them, poor beasts, to work a good deal, and eat in proportion.—The apparent subject *il* may suffer ellipsis, but then the remaining parts are inverted: *mieux vaut goujat debout, qu'empereur enterré* (La Fontaine), better a beggar a-standing than an emperor a-lying.]

b. Impersonal verbs conjugated reflectively:—

s'agir de, *to be at issue*;	il s'agit de, *the point at issue is.*
s'ensuivre, *to follow*;	il s'ensuit, *it follows.*
s'établir, *to gain ground*;	il s'établit, *it is gaining ground.*
se faire, *to happen*;	il se fait, *it happens.*
s'en falloir, *to be wanting*;	il s'en faut, *there is wanting.*
se passer, *to occur*;	il se passe, *there occurs.*
se pouvoir, *to be possible*;	il se peut, *it is possible.*
se rencontrer, *to happen*;	il se rencontre, *it happens.*

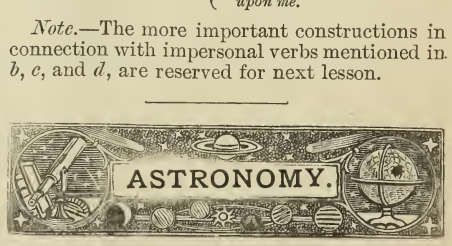
c. Impersonal verbs used with an indirect object of a person:—

échapper, *to do inadvertently*;	il m'échappe de, *I inadvertently.*
prendre, *to be seized by*;	il lui prit, *he was seized by.*
en prendre, *to get on*;	il m'en prendra, *I shall get on.*
tarder, *to long*;	il me tarde, *I long.*

d. Impersonal verbs which may appear with or without an indirect object of a person:—

arriver, *to happen*	il arrive, *it happens.* il m'arriva, *I happened.*
convenir, *to suit*	il convient, *it is proper.* il me convient, *it suits me.*
falloir, *to be necessary*	il faut, *it is necessary.* il me faut, *I want, or I must.*
importer, *to matter*	il importe, *it matters* il m'importe, *it matters to me.*
paraître, *to appear*	il paraît, *it appears.* il me paraît, *it seems to me.*
plaire, *to please*	il plaît, *it pleases.* il me plaît, *I choose, I please.*
sembler, *to seem*	il semble, *it seems.* il me semble, *I think.*
seoir, *to be becoming*	il sied, *it is becoming.* il me sied, *it is becoming in me.*
dépendre, *to depend*	il dépend, *it depends.* il dépend de moi, *it depends upon me.*

Note.—The more important constructions in connection with impersonal verbs mentioned in *b*, *c*, and *d*, are reserved for next lesson.



XLVI.

THE TELESCOPE.

OWING to the great advances which have been made within the last twenty years in the art of constructing telescopes, especially through the introduction of the new silver-on-glass reflecting telescopes, it is now possible to ob-

tain for a comparatively small sum an astronomical telescope equal in power to the finest instruments that were in use at the middle of the present century. For in the year 1850 the telescope in common use were ordinary achromatic refractors of from four to five inches aperture, those having apertures of as much as seven inches being considered exceptionally fine and powerful, whilst there were very few good instruments exceeding ten inches in aperture. Now, by far the greater number of telescopes in use are silver-on-glass reflecting telescopes with apertures ranging between six and nine inches, whilst instruments of from ten to twelve inch aperture are quite common. The older forms of reflecting telescopes were usually much inferior in power and performance to the ordinary achromatic refractor, but these new silver-on-glass reflectors are in every way quite as powerful as the far more costly refractor, whilst from their shorter focal length they are more conveniently mounted and managed.

At the present time, therefore, there are two classes of telescopes—the Refractors, constructed with an achromatic object-glass; and the Reflectors, constructed with a glass speculum or mirror coated on its upper surface with a highly polished film of silver, and almost invariably Newtonian in form.

The question Which form offers the greater advantages? is one which has not yet been definitely settled, and indeed is a question to which the answer may differ according as it refers to large or small instruments. The refractor possesses the advantage that when once adjusted it will rarely require readjustment, and will be always ready for use when wanted, even though it may have been lying idle for a long time. Moreover, its optical portion is not easily put out of proper adjustment by any ordinary treatment, so that it can easily be transferred from one place to another. The permanence of its optical axis also renders it more convenient for long series of exact micrometrical measures, whilst its tube being closed at both ends renders its definition steadier and less liable to be injuriously affected by change of temperature than is the case with a reflector. On the other hand, the refractor is less easy to mount with perfect steadiness than the reflector, requires a much larger observatory, and is, except in the case of small instruments, not so easily handled and managed. Moreover, even in the finest telescopes, it is not perfectly achromatic, and lacks something of the sharpness of definition of bright objects possessed by reflectors. The great advantage possessed by the reflectors is their compactness, their focal length being little more than half that of refractors of corresponding aperture, so that they are far easier to mount steady and to manage when mounted. They are also perfectly achromatic, and when in proper adjustment yield a wonderfully sharp and perfect image. Their great disadvantage is that they are more liable to get out of adjustment than refractors. This drawback, however, is not very serious, as after a little experience it is very easy to rapidly bring them back into satisfactory adjustment. They do not yield quite so steady an image, or quite so dark a field of view as the refractor, and as their optical axis is liable to be slightly changed in position by each readjustment, they are not quite so well suited for long series of measures with a micrometer. The greatest advantage of the reflectors, however, is their small cost. The optical part of a seven-inch refractor costs over a hundred pounds, whereas that of a reflector of corresponding size would not exceed a tenth of this sum. A completely mounted seven-inch refractor would cost about £350, whereas a reflector in every way as completely mounted, and twelve inches in aperture, would not cost £250.

For exact micrometrical work it is probable that a refractor will be generally preferred, and up to seven or eight inches aperture this will generally be the case where expense is no consideration, or where only occasional observations are to be made. For general physical observations of the heavens, however, and especially of the details visible on the surface of the moon and planets, for observations of their satellites, for searching for comets and new nebulæ, and in fact for all purposes where power is required, a reflector will generally be found preferable. For apertures exceeding eight inches the advantages of the reflectors become steadily on the increase.

The first thing to be considered in an astronomical telescope is the character of its mounting, for however excellent may be the optical part, it will never perform its work well unless it be properly mounted on a steady and convenient stand and be provided with all proper adjustments. A large telescope inadequately mounted will never be found so satisfactory as a smaller one properly mounted; nor indeed will it be found so powerful as the smaller, for whereas the smaller telescope will perform to the utmost of its powers, owing to the want of a steady stand and proper fittings, it will be impracticable to call forth more than a portion of the full power of the larger instrument. The stand of an astronomical telescope may be of two forms—an *altazimuth* or an *equatorial*. In each case the instrument moves on two axes at right angles to one another, the difference being that in the alt-azimuth one of these axes is horizontal and the other vertical, so that the telescope moves in altitude or in azimuth; and in the equatorial one axis is placed parallel to the plane of the terrestrial equator, and the other parallel to the terrestrial axis of rotation, so that the instrument moves in declination and right ascension. The advantage of the latter form is obvious, for the telescope can be made to follow a star in its diurnal motion in the heavens by merely moving it around one axis or in a right ascension direction, whereas in the altazimuth it is necessary to move it around both axes in order to follow the apparent daily motion of the stars in the heavens.

THE ALTAZIMUTH.—The only advantage possessed by this form of stand is its simplicity and consequent cheapness. In all other respects

it is much inferior to the *equatorial*, so that its use is restricted to the smallest and cheapest instruments, or to those of very large dimensions, which are very costly to mount in a more complete manner. Small refractors from $2\frac{1}{2}$ to 4 inches in aperture are commonly mounted on a tripod stand of this form; but they are scarcely adapted for astronomical purposes, being too small for observing the minuter features of the heavens, and too inadequately mounted for purposes of exact measurement. In consequence, as far as astronomical telescopes are concerned, this kind of mounting may be regarded as restricted to reflectors. A very convenient form of such mounting is shown in fig. 105. Astronomical telescopes mounted in this manner are now far from very expensive. A completely mounted reflector of from $6\frac{1}{2}$ to $8\frac{1}{2}$ inch aperture, with eye-pieces complete, can be purchased for from £25 to £50. With an instrument of this size good useful astronomical work can be done, especially in the study of the details visible on the surface of the moon and planets. The optical part of such a telescope—namely, the silvered glass speculum, the small plane silvered mirror, and the eye-pieces—can be purchased for rather less than one-half of the above sum; and in the hands of one used to tools can be mounted in a tolerably fair manner for about £5. As a rule, however, it will be found far more satisfactory to purchase the telescope with its tube and fittings complete, and confine oneself to making the stand alone. Telescopes of the above form, with their tubes and fittings complete, would cost from £16 to £35.

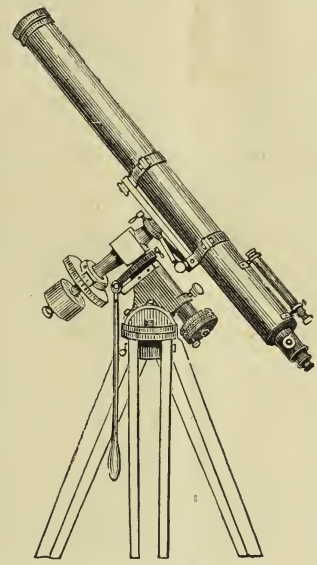


FIG. 106.

THE EQUATORIAL.—In this form of mounting the telescope turns on two inclined axes placed at right angles to each other; one, termed the *polar axis*, being placed in the plane of the meridian and pointing to the pole of the heavens, so that it is parallel to the axis of the earth; the other, termed the *declination axis*, lying parallel to the plane of the equator. Consequently, when the telescope is moved round its declination axis, it follows a great circle in the heavens, called "hour circles" (see vol. i., p. 340), on which are measured the declination of a star or other heavenly body; and when the telescope is moved round its polar axis, it moves in a circle parallel to the equator, and therefore in the same manner as is measured the right ascension of a body (see vol. i., p. 340). Hence, by merely moving the telescope round its polar axis, it will completely follow a star in its daily motion in the heavens due to the rotation of the earth on its axis. If the instrument be fitted with a clock-work motion which makes the telescope turn once on its axis in a sidereal day, the telescope when once turned on a star or other point in the heavens will always remain pointing exactly on the same star or spot. Moreover, by fitting properly adjusted graduated circles on the polar and declination axes, by inspecting these circles it is possible to tell the exact place in the heavens at which the telescope is pointing—that is, its exact right ascension and declination; and *vice versâ*, by turning the telescope until the circles show the proper right ascension and declination, the telescope may be directed to any particular point in the heavens. Thus, if the right ascension and declination of a star or other body be known, the telescope can be at once made to point exactly at it, by moving the telescope until the circles indicate the right figure.

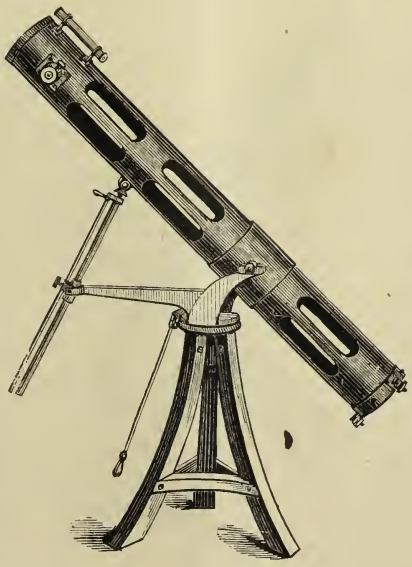


FIG. 105.

There are very considerable advantages, therefore, in this form of mounting. First, it is very easy to make the telescope follow a star for as long as may be desired, keeping it always in view; secondly, the telescope can be at once turned with certainty on any star or other heavenly object, whether it be visible or not; and, thirdly, the right ascension and declination of any object visible in the telescope can be ascertained at once, and its identification secured without further trouble.

From what has been said, it is apparent that equatorial stands must be properly adjusted

and placed in the plane of the meridian. This, is easily done once and for all. As a rule, equatorial mountings are not meant to be moved after being once placed in position. Even, however, if a portable instrument be required, it is always possible to mark the position of any three points on the base of the stand, and then the mounting can always be restored to its proper position.

Equatorial mountings may be divided into two classes—*simple equatorials* and *complete equatorials*, only differing in the number and completeness of their accessory fittings.

THE SIMPLE EQUATORIAL.—In this form the fittings and adjustments are made as simple as possible, the circles showing the declinations and right ascensions are not very finely graduated, generally only to 5′ of declination and 10″ of time, which is ample for the purpose of finding or identifying stars or planets. They are not provided with clock motion or with micrometers and other expensive accessories. In all other respects they have all the advantages of an equatorial mounting.

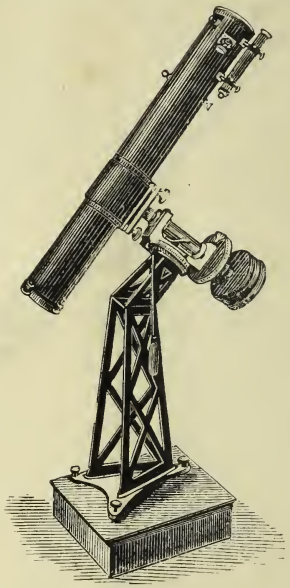


FIG. 107.

Fig. 106 shows a very good form of such a mounting for a refractor of from four to six inches aperture. Larger instruments of this kind are rarely mounted except in the most complete manner, for the optical part of the instrument is so expensive that little is gained by a less costly mounting. These instruments can be regarded as portable, and carried indoors when not in use, it being easy to mark the exact place of the legs of the tripod when the stand is in its proper position, and so always restore it to its proper place when required for observation. Instead of a tripod stand, as shown, these instruments are often mounted on an iron pillar. They are then steadier and more permanent, but require to be sheltered by an observatory of some kind. Telescopes of this kind cost from £60 for a four-inch to about £200 for a six-inch. The stands alone cost from £25 for one suited for a four-inch telescope to £75 for one suited for a six-inch.

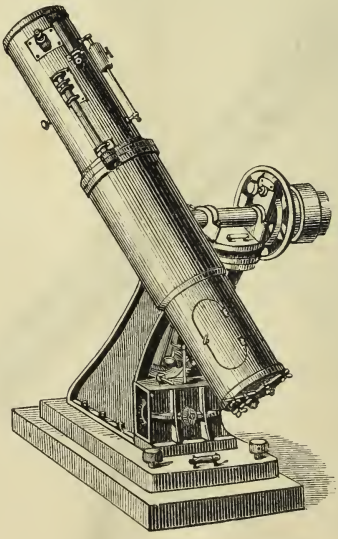


FIG. 108.

Fig. 107 shows a similar mounting for a reflector of from six to twelve inches aperture. These instruments, as a rule, are somewhat too heavy to be regarded as portable, but are easily sheltered under a low cover. They cost about £35 for a six-inch, about £70 for an eight-and-a-half-inch, and £100 for a twelve-inch. The stands by themselves cost about £15 to £35, according to their size.

With these instruments, even the smallest, it is possible to do an enormous amount of thoroughly good and satisfactory astronomical work.

THE COMPLETE EQUATORIAL.—The principal feature distinguishing between these and the preceding class of instruments lies in their possessing a clock motion by which the polar axis is rotated so as to automatically follow the motion of a star in the heavens. This enables them to be fitted with micrometers and other expensive accessories. To obtain the full advantage of these mountings it is necessary that the instrument should be most carefully adjusted in position and maintained in adjustment. In consequence they are in no respect portable, and must be sheltered under an observatory. Refractors of this kind cost about £500 for a six-and-a-half-inch and some £1000 for a ten-inch; they need, moreover, somewhat expensive observatories. Reflectors of this kind are not so costly; but small instruments are not commonly mounted in this elaborate manner. One of ten inches aperture costs about £200, and one of fifteen inches aperture about £350. Fig. 108 shows a capital example of a mounting of this kind. Observatories for these instruments are not expensive, for they lie low and are very compact. Thus a ten-inch reflector requires an observatory only ten feet in diameter, and not necessarily more than eight feet high, whereas a refractor of similar size would require a dome fifteen feet in diameter and twenty feet high.

So much for the telescopes themselves; upon details of their construction and adjustment it would be out of place to touch here; particulars of this kind can be easily learnt from the little handbooks published at a nominal cost by nearly all the makers. Little more than expensive experience will be gained by any inexperienced persons trying to construct astronomical telescopes for themselves. Directions for such a purpose are useless.

LIII.

The Gerund and Gerundive.

1. The gerund is a verbal substantive used in all cases except in the nominative and vocative —as, for example, in *amandi*, of loving; *amando*, to, for, or by loving; and *ad amandum*, for the purpose of loving.

Observe that the cases of gerunds have precisely the same construction as the corresponding cases of ordinary substantives; as—

(1) *Genitive*—as *Usus præceptis Latine scribendi*, having used the rules of Latin composition.

(2) *Dative*—as *Aqua utilis bibendo*, water useful for drinking.

(3) *Accusative*—as *Se dedit ad benè honestique vivendum*, he gave himself up to living virtuously and honourably.

(4) *Ablative*—as in *Orator in omni genere dicendi exercitatus*, an orator practised in every kind of speaking.

The infinitive present may be used for the nominative case of the gerund.

The gerund as a verbal substantive has still the power of governing its proper case as a verb—as in *Diogenes dicebat, artem se tradere vera ac falsa dijudicandi*, Diogenes used to say that he could transmit the art of distinguishing between things true and things false.

2. The *gerundive participle* signifies that a thing is necessary or proper to be done. It is always passive in meaning, whether answering for a verb strictly passive or for a deponent verb. It is used in the following constructions :—

(1) It is put in the nominative case along with the verb *est* or *sunt*, in agreement with a substantive, to signify that something *ought to be done*—as in *Virtus est colenda*, virtue is to be cultivated ; *Pueri sunt educandi*, boys are to be educated.

(2) It is used *impersonally* in the neuter gender along with the verb *est*, with the same force as in the former case—*i.e.* to show that something ought to be done—as in *Nunc est tyranno resistendum*, now we must resist the tyrant. This usage is always adopted when the verb governs any other case but the accusative.

(3) It is put into all cases except the nominative or vocative in agreement with a substantive as equivalent to a gerund governing the accusative (the *agent being always* put in the dative case)—as in *Ars benè vivendi est difficilis*, the art of living virtuously is difficult. The gerundive is frequently used instead of the gerund when the verb governs the accusative, but with the following changes :—

(α) The accusative is put in the same case as the gerund.

(β) The gerund is changed into the gerundive.

(γ) The gerundive, being an adjective, agrees with its substantive in gender, number, and case—as *Ars pueros educandi difficilis est* becomes *Ars puerorum educandorum difficilis est*. Here observe that *pueros*, the substantive of the first sentence, is put into the same case as the gerund *educandi*, and a genitive, and consequently we have *puerorum* ; the gerund *educandi* is changed into the gerundive *educandus, -a, -um*, and thus is made to agree with *puerorum* in gender, number, and case, and so becomes *educandorum*.

The dative, and more rarely the genitive, of the gerundive is used to denote a *purpose* or *result*—as *Decemviri legibus scribendi constituti sunt*, the decemvirs were appointed for the purpose of making laws ; and in *Initit consulatum conservandæ libertatis*, he entered upon his consulship with a view to the preservation of liberty.

The gerund may be used like an ordinary substantive—as in *Castra venerunt purgandi sui causâ*, they came into the camp for the sake of clearing of themselves.

Dr. Kennedy gives us the following sound and philosophical account of the gerund and gerundive :—

"These constructions are a striking feature in Latin. In its sense of meetness or necessity, in its adjectival power and double use as transitive and passive, the gerundive resembles the Greek participial in τεὸς, but in other respects the resemblance fails : the Latin gerund supplying the verb-noun with that system of oblique cases which Greek obtains by the flexible and graceful power of the article attached to the infinitive. Some scholars would assign the gerundial construction to the active voice throughout ; but their mode of explaining the evidently passive force of the participle in *-dus* is not satisfactory. The suffix *nd* appears to connect the gerundive with the present participle in *nt* ; but such examples as *volvenda dies* (ἑλλόμενος χρόνος) (Virg.) ; *ante conditam condendamque urbem* (πρὸ κτιζομένης της πόλεως) (Liv.), point rather to a present participle passive. Whatever the theory, the facts of the gerundial construction are these : 1. The gerundive participle in *dus*, by its neuter singular, supplies a verb-noun (*-dum, -di, -do*), which furnishes a substantival case-system to the verb infinite : the genitive, dative, and ablative exerting the active power of the infinitive ; the accusative also, but only when joined with prepositions. These are called gerunds. The nominative of this noun is used only in the impersonal construction, with the sense of meetness, obligation, or necessity—*utendum esse ætate*. 2. The next step is the remarkable attraction by which the oblique case of a transitive gerund and its object mutually affect each other ; the object assuming the case of the gerund, the gerund the number and gender of the object. 3. Last is the adjectival use of the gerundive participle, with the sense of meetness, either as epithet or complement—*laurea* DONANDUS *Apollinari*, meet to be presented with Apollo's laurel (Hor.) This must not be regarded as a future participle passive, nor as expressing possibility. A future sense may sometimes be implied, but it arises from the connection, not

from the participle simply taken. So, in a few instances, possibility may be implied by a secondary meaning—as *malum vix ferendum*, an evil hardly fit to bear—*i.e.* hardly bearable."

Self-Examination Questions.

What is Dr. Kennedy's theory about the gerund and the gerundive? Define the gerund, and distinguish it from the gerundive. What is to be used for the nominative case of the gerund which is lacking? Give an instance of a verbal substantive with the infinitive as nominative case and the gerund as genitive, dative, accusative, and ablative. When the gerund is used as a verbal substantive, does it still retain the power of governing its proper case as a verb? Give an instance of this. What is denoted by the gerundive participle? Give its three methods of construction, with examples. Show the different constructions with verbs governing the accusative and other cases than the accusative case. Show that when the verb governs the accusative the gerundive is frequently used instead of the gerund. What is often expressed by the dative and genitive of the gerundive? Give examples.

Exercises.

Translate into English :—

Ad rectè agendum et ad benè vivendum nati sumus. Epaminondas studiosus erat audiendi. Ei ira in puniendo puero erat. Consul satisfaciendi reipublicæ nostræ jam diu cupidus fuerat. Non mihi unquam fuit consuetudo falsa dicendi et vera dissimulandi. Cives armati ad tuendam urbem et ad liberandos socios fideles prodeant. Inter ludendum pueri mores suos ostendunt. Nosne ad agros colendos nati sumus? Ars canendi est perdifficilis. Hoc studium linguarum ingeniis acuendis puerorum aptissimum est. Tiberius Gracchus a Romanis civibus triumvir dividendis agris creatus est. Nullum officium referenda gratia magis est necessarium. Patriæ a nobis subveniendum est. Antigonus hostem suum sepeliendum tradidit. Non pœna timenda est. Cæsar ad oppugnandam urbem milites e castris eduxerat. Breve tempus ætatis satis est longum ad benè beateque vivendum. Stultissimi multo (*by far*) discipulorum sunt ii, qui discendi sunt minimè studiosi. Præceptores inter docendum nonnunquam omittunt mentibus puerorum si accommodare. Socrates interrogando dicere solebat eorum opinionie,quibuscum disserebat. Virtutes hominum in agendo cernimus. Multi homines audiendo magis sunt idonei, quàm dicendo. Ars benè et apte (*to the point*) dicendi plurimum valet in foro et in judiciis. In consilio capiendo considerare debemus, quot et quanta sint nostra pericula.

Translate into Latin :—

He is clever (*peritus*) in administering the affairs of the state, but slow (*segnis*) in praising virtue. This kind of weapons (*armorum*) is useful for protecting the body. Virtue is seen clearly (*cernitur*) in despising bodily pleasures (use *voluptas*). Themistocles was very prompt in transacting business (use *agere*). We must spare the citizens (remember that *pareere* governs the dative case, and therefore its gerundive must here also govern the dative). Necessity compels men to learn many useful things. Pompeius made the sea safe by overcoming and destroying pirates. By watching, by acting, by consulting well, all things will turn out well, if only the gods assist us. The greatest pleasure comes from learning. Scipio is recalled to defend his country against its enemies. The lust of ruling (use *cupido*) is even in the minds of the greatest men. The judge was desirous of hearing the accused (*reus* = an accused person). Do you fear the difficulty of speaking? This garment is most suitable to adorn women. He pays very great attention (use the superlative degree of *studiosus*) to riding (*equitare* = ride). Hannibal sent out spies to explore the road. Fabius Pictor was sent by the senate to inquire. Envoys (*legati*) came concerning the injuries that had been received. By confessing the truth you will receive a most full pardon. How many men are prepared to defend their country even to the death? These precepts are most useful for directing the life of the good and the wise man.

Syntax of the Supine, and other Uses of the Verb.

A. The Supine.

THE two supines which end in *um* and *u* are properly the accusative and ablative cases of verbal substantives of the fourth declension.

(1) The first supine (in *um*) marks *purpose* after a verb of actual or implied motion—as LUSUM *it Mœcenas, dormitum ego*, Mœcenas goes to play, and I to sleep.

(2) *Ire* is used with the supine in *um* to express *the going about* a thing for the purpose of doing it—as *Perditum ire*, to go about destroying oneself; hence arises the impersonal infinitive *iri* with the supine to supply a passive form for infinitive future—as in *Audierat non datum iri filio uxorem suo*, he had heard that a wife would not be given to his son; and hence, too, such idioms as *Eunt consultum Apollinem*, they go to consult Apollo.

(3) The second or ablative supine, which ends in *u*, is constructed with the undeclined substantives *jas, nefas, opus*, and various *qualitative* adjectives which signify *good or evil, pleasantness or unpleasantness, fitness or unfitness, ease or difficulty*—as in *Nefas dictu*, a sin to be told; *terribile visu*, terrible to be seen.

(4) In poetry the infinitive may be used instead of the supine in *u* after adjectives—as in *Cereus in vitium flecti*, waxen to be moulded into vice.

(Observe that the supine in *u* may be often best translated by the English infinitive mood —as in *Mirabile dictu, tetrum visu*, wonderful to tell, foul to look upon.)

B. Various Verbal Usages.

(1) The passive verb is used sometimes *impersonally*, either when the subject, being obvious, is easily supplied from the context, or when it is indefinite—as *Ager in quo pugnatum est*, the field in which it was fought—*i.e.* the

battle (*prælium*) was fought; *Hostes venire allatum est*, word was brought that the enemy was coming.

(2) The passive verb is sometimes used in a middle or reflective sense, and especially with verbs which imply *motion*, as *moveri*, to move myself, *mutari*, to change oneself — as in *Vertitur interea cœlum*, meanwhile the sky is changing.

(3) The perfect indicative is often used, especially in poetry, to indicate that which *regularly* or repeatedly takes place—as in *Sæpe etiam steriles incendere profuit agros*, often, too, it is of advantage to set on fire the barren fields.

(4) The verb is often omitted, especially the verb *sum*—as in *Quot homines, tot sententiæ*, many men, many minds. The following verbs also are often omitted: *inquam, inquit, dico, dicit*, and *dicat* (*dedicates*)—as in *Salutem* (*dicit*) in letters, he greets; *Tum Citta* (*dicit* or *inquit*), then says Citta.

(5) The verb is occasionally repeated, especially in the answer of a question—as in *Nempe negas ad beate vivendum satis posse virtutem? Prorsus ego nego*, forsooth do you deny that virtue is sufficiently powerful for a blessed life? Yes, I do altogether deny this.

(6) The imperfect participle may be used sometimes as a *substantive*, especially in the *plural number*—as in *Hoc genus deliberantium pellatur e medio*, let these sort of questioners be driven from our midst. (Observe that here *deliberantium*, the participle genitive plural, is to all intents and purposes a *substantive in meaning.*) Occasionally, but rarely, the future participle is used in the same *substantive* meaning, and especially in the plural and in the nominative case—as in *Illud quod tantum perituri vident*, that which only the doomed to perish see.

(7) The perfect participle passive is used substantively both in the *masculine* for *persons* and in the neuter of things or acts—as in *Ut de vi et majestate damnati ad populum provocent*, that those condemned for violence and treason should appeal to the people; and in *Facta illustria et gloriosa*, exploits distinguished and glorious. To this idiom we may refer such Latin phrases as *ex compositio*, by agreement; *ex empto*, by purchase; *ex vendito*, by sale.

Self-Examination Questions and Exercises.

Define a supine. Distinguish the character of the supine in *um* from that of the supine in *u*. Show the different constructions of each of these supines, and give examples of each. What cases of the verbal noun does each of these supines represent? Account for the idiom "*Eunt consultum Apollinem.*" What do you mean by a middle verb in Latin? What kind of verbs are often such? Give examples. What is sometimes the force of the perfect? Give examples. What verbs are sometimes *omitted* and what are repeated in a Latin sentence? Give examples of the substantival use of the present and the future participles.

Translate into English:—

Coriolanus in Volscos exsulatum abiit. Id quod optimum factu videbitur, tu facies. Humanus animus cum alio nullo, nisi cum ipso Deo, si hoc fas est dictu, comparari potest. Quid est tam jucundum cognitu atque auditu quàm sapientibus sententiis gravibus verbis ornata oratio? Bello Helvetiorum perfecto, totius fere Galliæ legati ad Cæsarem gratulatum convenerunt. Legati ab Româ venerunt questum injurias et ex fœdore res repetitum. Cur, o stultissime hominum, ita te ipsum is perditum? Dumnorix ipse propinquas suas nuptum in alias civitates collocavit. Narratio brevis erit, si non longius, quàm quòd scitu opus est, in narrando procedetur. Hoc fœdus ex composito violaverunt. Clamores paventium ad aures venerunt. Soli ratione utentes jure ac lege vivunt. Dasne aut manere animos post mortem, aut morte ipsâ interire? Do verè. Di tibi meliora? Æneas hæc de Danais victoribus arma. Salutem tibi. Quid multa et graviora? Omnia præ dara atque optima factu rara. Hinc apicem Fortuna sustulit, illic posuisse gaudet. Quod semper movetur est æternum. De quo putas ad me missum esse, sit missum necne nescio. Animus cjus audax, subdolus, varius, cujuslibet rei similator ac dissimilator. Tumultuatim in castris hostium fuit. De Tarentinis magnâ contentione in senatu actum Quum urbem vi cepissent, captamque diripuissent.

Translate into Latin:—

This matter is most difficult to decide (*dijudicare*). This wine is sweet to drink. What can be more pleasant to hear and to see than this? The destruction of the city (say the city destroyed) was sad to see and miserable to tell of. All things which are disgraceful to do are disgraceful to mention. Is he going to Rome to overthrow his enemies? Did he go to Greece to consult the oracles of the gods? This city is very difficult to defend, and very easy to take. I heard that there was no intention of giving to me the daughter of the king as a wife. May the gods grant a better lot (say better stars) to this city and to its king. Dare you deny that these things are terrible to relate? I do most certainly deny it. The men who deliberate should be punished at once with death. Cæsar sent many ambassadors from his camp to the king of the Greeks to ask for peace. This sword is dangerous to touch, for it easily wounds those who touch it. Many women, many voices. He has gone to sleep, while others have gone to play and to hunt. This has been done according to agreement. This is his house by purchase. Why has he gone to Rome so suddenly? is it to buy a house? Have the boys gone to walk in the garden of their mother? (Yes.) Has this traitor of the country, so terrible to look on and so disgraceful to tell of, gone away from the city to exile? Why do you go away to destroy yourself? Tell me, if you can, what is best to be done, and what dangers are most easily to be avoided. Dare you deny that it is disgraceful to defend the wicked? Certainly, there are two sides to every question.

X.

Bones of the Face.

The largest and most characteristic bones of the face are those which constitute the basis of the upper and lower jaws, the superior and inferior *maxillary** bones. These bones support all the teeth, and the upper forms a great portion of the palate. The superior maxillary bone occupies most of the cheek; it sends up a strong spur on the inner side of the orbit to reach the nasal and frontal bones, and has a very prominent tuberosity just below the outer angle of the eye, giving rise to a noteworthy feature of the face.

Maxillary bones.

Relation to features.

The maxillary bone has a large hollowed part above the mouth, supporting on the top a smooth flat surface which forms a portion of the floor of the orbit. The palatal plate of the maxillary is a very regular, concave surface, and the right and left plates meet exactly in the middle line; combining together as the roof of the mouth. The two bones meet in the middle line also on the front of the face and in the nostrils.

Formation of palate.

Some important features must be mentioned in relation to the nerves of the face. For protection, many of them run in bony canals. The nerves and bloodvessels for the cheek come out on the face from a canal in the upper maxillary bone, a little below the the lower eyelid. There are perforations in the hinder part of this bone, into which the nerves and arteries of the upper teeth enter, coursing in bony canals to the points where the fangs of the teeth are inserted, and then branching into the pulps of the teeth.

Bony canals for nerves and bloodvessels.

Dental nerve-canals.

The lower maxillary bone, the most solid and massive bone of the face, has a semi-elliptical shape, and moves upon the rest of the skull by two articulating surfaces, the *condyles*. These are small transversely elongated convex bosses, which play in the pits we have described on the temporal bones. These maxillary condyles are situated at the upper and back part of the bone, so that the whole mass can be moved upwards and downwards about them.

Lower maxillary bone.

Condyles.

The bone has two main regions—the dental or horizontal, and the ascending portion. The latter is somewhat square-shaped, and has attached to it the powerful muscles of mastication. In front it is prolonged upwards into a sharp triangular portion, which is well covered up beneath the zygoma, and to this, mainly, the powerful temporal muscle is fixed.

Regions dental and ascending.

Coronoid process.

* Lat. *maxilla*, a jaw.

The horizontal portion of the jaw has nothing particular to note externally, except the bony prominence of the chin, and one or two holes by which nerves, which have traversed the bone, come out to supply the skin and muscles. The inner deep surface of the bone presents strong ridges and bosses for attaching muscles of the tongue, and a hole in the middle of the ascending portion, by which the nerves and bloodvessels for the lower series of teeth enter the bone.

Ridges and holes.

There are several other bones of the face, but it is somewhat difficult to realise their position without seeing the bones. The *palatine* has a curious shape: part of it forms the back of the hard palate; there is a vertical piece running up behind the upper jawbone, and crowned by a little boss which enters into the floor of the orbit.

Palatine bone.

The lachrymal is another small bone belonging to the orbit. It is somewhat scale-like, and placed on the inner side of the orbit next the nasal bone. It is chiefly remarkable for a vertical groove, which fits against another groove on the maxillary bone, and so forms a canal leading from the orbit to the cavity of the nose. This is the lachrymal canal, by which the overflow of moisture from the eye is carried away.

Lachrymal.

Lachrymal canal.

The pair of *nasal* bones form the bridge of the nose; they extend downwards for rather more than one-third of the length of the nose, broadening as they descend. The *malar* is a curiously shaped bone, which forms the outer and lower part of the orbit, and extends backwards to join the zygoma coming forwards from the temporal bone.

Nasals.

Malar.

The last group of bones to be considered are those which constitute the nasal cavity internally. There is a compound bone called the *ethmoid*, which has (1) a horizontal part wedged in the front part of the brain-case, between the frontal and the sphenoid, and perforated by a number of small holes for the nerves of smell to pass through; (2) a thin vertical plate, forming the greater part of the partition or septum between the two nasal cavities; and (3) lateral masses.

Ethmoid.

Horizontal, vertical, and lateral parts.

The lateral masses of the ethmoid have a smooth surface above, which forms, to a considerable extent, the inner wall of the orbit. Connected with this plate below is a quantity of thin plates and laminæ of bone, which are curved and combined in a curious manner, and upon them the nasal membrane is extended. These are the spongy bones—one of which, the lower, is quite separate from the rest of the ethmoid, and only attached to the upper jaw-bone. There is yet another bone, the *vomer*, or ploughshare, which is fitted above and in front to the middle plate of the ethmoid and to the sphenoid, and below to the nasal floor formed by the conjoined maxillary bones. Thus it makes the nasal system very complete.

Spongy bones.

Vomer.

XLIX.

Rome (*continued*).

Up to the time of Augustus, the provinces, as we have seen, were governed despotically and often with great cruelty by Roman governors, who had no sympathy with the native people, and only looked upon them as tenants holding at the will of the Roman people, from whom the latter had a right to squeeze all the money they could, by fair means or foul. Now Augustus altered this. In the first place, by taking into his own hands the supreme power at Rome itself, he deprived the worthless Roman rabble of the privilege which they had hitherto enjoyed, of appointing the provincial governors, so that the latter were no longer men who had bought their offices with extravagant gifts to the people. They were for the most part chosen for their merits by the emperor; and even when the senate was allowed to choose them they were watched and controlled by the emperor's officers, and punished by the emperor if they deserved it. The relief to the oppressed provinces was so great that Augustus was worshipped with the honours of a god by many of them. In the next place, he began to bestow gradually upon the provinces the privileges of Roman citizenship, thus making them the equals of their old masters. This process, begun cautiously by Augustus, was carried out by his successors. It is true that this did not give the provinces any share in the government of the empire, for the simple reason that the emperors had now usurped all political power themselves; but it admitted the provincials to the benefits of Roman law, which were very considerable, and made them the equals before the law of the officials who carried on the provincial governments. Casting a glance backwards, we see what had happened was this. After the social war all Italians had been admitted to the citizenship, but they could take no part in the government without coming to Rome to vote, so that political power still remained in the hands of the Roman rabble, until the emperors took it away and exercised it themselves. Then the emperors gradually bestowed on the provinces such privileges as still remained to the Roman citizens, and thus the inhabitants of the whole empire became equals before the law; but none of them any longer possessed the old political power which belonged to the citizens in the times of the republic.

Improved government of the provinces.

Extension of the Roman citizenship.

The only foreign wars waged by Augustus were against the Germans; and though on the whole successful, he suffered one terrible defeat from Arminius, or Hermann, who, in the year A.D. 9, destroyed almost the whole of the Roman army under Varus, and drove them out of the country between the Elbe and the Rhine, —the very country from which our own Saxon ancestors came some four centuries later. This defeat weighed heavily on Augustus during the few remaining years of his life. It is said that he used to cry out in his sleep, "Varus, Varus, give me back my legions!" Domestic troubles also helped to cloud his last years. None of his own blood appeared worthy to succeed to his place, so he chose his step-son, Tiberius Claudius Nero, the son of his second wife, Livia, by her former husband.

War with the Germans.

Adoption of a successor.

Augustus died peacefully in the year A.D. 14, at the age of seventy-seven, having held supreme power for forty-four years, from B.C. 30 to A.D. 14. He was a very great man, and a wise ruler, and so the immense power which he got into his hands was well used; but there are not many men in any age, and there were certainly very few among the demoralized Romans of that time, who were capable of holding such power without abusing it; and so we find that those who succeeded him were guilty of the most frightful crimes.

Death, A.D. 14.

Tiberius began fairly well. He was not a favourite personally, being of a stern, gloomy disposition; but for some years he devoted himself earnestly to the hard work of governing the empire. But gradually he became tyrannical and suspicious, and put to death great numbers of the old Roman nobility, out of fear or jealousy. He surrounded himself with a bodyguard of 6,000 armed men, who were called "*the Prætorian guard*," of whom we shall hear more. Towards the end of his life he lived in seclusion away from Rome, looking with indifference upon the cruelty and injustice which were done there under the cloak of his name.

Tiberius, A.D. 14–37.

The Prætorian guard.

After his death, at the age of seventy-eight, his adopted grandson, Caligula, succeeded him, and proved to be even a worse ruler, for besides being as cruel and suspicious as Tiberius, he was one of the silliest men who ever sat on a throne; and, indeed, there is little doubt that he suffered from the insanity which was hereditary in his family. He was at last murdered by some of his attendants, and there was no one to succeed him. Had the senate been bold and united, they might have restored the republic; but they could come to no decision, until some of the Prætorian guards, roaming about the palace, found the late emperor's uncle Claudius, hiding in terror, and insisted that he should be emperor. He was believed to be a half-witted poor wretch, who had escaped death so far only because he was beneath contempt; but the senate were compelled to agree to the caprice of the Prætorians, and to accept Claudius as their emperor. He was a well-meaning man, but knew nothing about governing an empire. His wife, a detestable woman, who had been married before, and had a son

Caligula, A.D. 37–41.

Claudius, A.D. 41–54.

Nero, by her first husband, induced him to adopt this Nero, a youth of sixteen, as his successor, and then poisoned the unfortunate Claudius to make way for her son.

This Nero, whose name has passed into a proverb for cruelty, was a son worthy of his mother, and showed his gratitude to her by having her brutally murdered. His name is perhaps best known by its association with the great fire which took place in Rome in the year A.D. 64. He appeared to be delighted at the catastrophe, and amused himself "fiddling" on the top of a hill from which he could have a good view of the burning city. It was even thought that he had ordered the fire himself; but he allowed the Christians to be charged with this offence, and great numbers of them were in consequence put to death with horrible tortures. At last, Galba, at the head of the Spanish and Gaulish legions, determined to march against him; and Nero, after fourteen years of abominable misconduct, while still a young man of thirty years of age, found himself so abhorred by every one, and so absolutely deserted, that he was driven to put an end to his own hateful life. He had no children, and the Julian family came to an end with him. Galba was proclaimed emperor by the Spanish legions; and though he had no title whatever, the senate elected him.

Nero, A.D. 54–68.

Burning of Rome, A.D. 64.

Galba, A.D. 69.

CLAUDIUS CÆSAR.

But Otho, one of his generals, persuaded the Prætorian guards to kill the new emperor, and got himself proclaimed in Galba's place. The German legions were not satisfied with this, and did not see why their own general, Vitellius, should not be emperor. So they marched against the Prætorians, and defeated them; Otho committed suicide, and Vitellius became emperor.

Otho, A.D. 69.

But Vitellius could do nothing but eat and drink. The Syrian legions determined to have *their* emperor; so they proclaimed their general, Titus Flavius Vespasianus; and after some fighting Vitellius was killed, and Vespasianus reigned in his stead (A.D. 69). This year, A.D. 69, had seen no less than three new emperors proclaimed by the soldiers, and deposed by them, and now a fourth had come; and with him begins a new chapter in the history of the empire.

Vitellius, A.D. 69.

Vespasian, A.D. 69–79.

Vespasian reigned only ten years; but in that time he introduced a healthy tone into the government of the empire, which fortunately was kept up and further improved by most of his successors for the next hundred years, so that this period was one of the happiest and grandest in the whole history of the Roman world. Vespasian did not, like Augustus and his successors, belong to a great and ancient family, and had no excuse for pretending that he was of divine descent. His authority rested at first simply upon the army who had proclaimed him; but he ruled so wisely and justly, and treated the senate and the laws of the country so respectfully, that he soon had the hearty support of all that was best in the state. He set a wholesome example of simplicity in his way of living, and of obedience to the law, which produced good fruit in Rome itself. He also restored discipline in the army, and made it once more the servant of the state, instead of its master.

Good government.

Vespasian died in 79, and was succeeded by his son Titus, who had already distinguished himself by the taking of Jerusalem, after one of the most terrible sieges recorded in history, the horrors of which were due not so much to the cruelty of the Romans as to the fanatical obstinacy of the Jews, who savagely rejected every offer of compromise, and to the internal feuds in the city, which raged unabated through the siege. With the fall of Jerusalem and the destruction of the Temple, the national independence of the Jews, which the emperors had hitherto partially spared, was finally and totally extinguished. Titus and his father built magnificent public baths, which were called after the former, and a monster circus, or *Arena*, in which gladiatorial shows were held. It was called the *Colosseum*, and its ruins are even now amongst the most imposing in the world. A great eruption of Mount Vesuvius, near Naples, completely buried two flourishing and fashionable seaside resorts

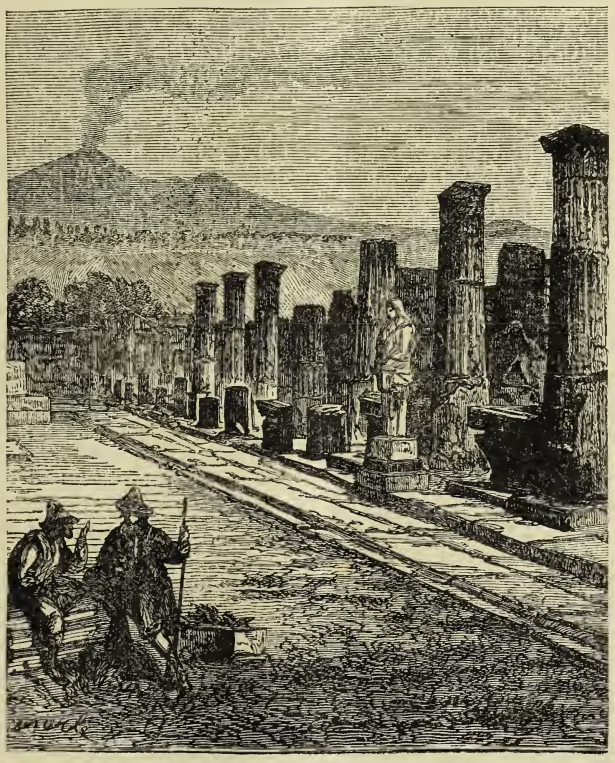
Titus, A.D. 79–81.

Conquest of the Jews.

Public buildings.

Destruction of Herculaneum and Pompeii, A.D. 79.

in the year 79. Pompeii was only covered with ashes and cinders, but until the middle of last century no effort was made to excavate it, and even its site appears to have been forgotten. But since then a great portion of it has been cleared, and the streets and walls of the houses are now laid bare to view, and we can see them as they were eighteen hundred years ago, the very paintings on many of the walls being as bright and fresh as if the artist had only just finished them, so completely have the ashes preserved them from natural decay as well as wilful mischief. A vast number of things in daily use, such as lamps, vases, tools, jewellery, etc., have been found in the ashes, as well as a few human bodies. Herculaneum, the other buried city, was overwhelmed by a stream of molten lava, which as it hardened became like solid rock. It is therefore very difficult to excavate.



VESUVIUS FROM POMPEII.

Titus was greatly beloved and admired by the Romans, and it is said that he used to reproach himself, exclaiming, "I have lost a day!" when he had allowed a day to pass without doing some beneficent action. His short reign of two years was terminated by decline, and his brother Domitian succeeded him as the head of the Roman empire.

Domitian was the worst of the Flavian emperors, and after a reign of fifteen years he was murdered in revenge for his cruelties. The most noteworthy event of his reign was the extension of the Roman authority in our own island.

Domitian A.D. 81–96.

Conquest of Britain.

The first serious attempt to conquer Britain had been made by the emperor Claudius. He landed in Kent in the year 43, crossed the Thames into Essex and Hertfordshire, subduing the tribes which inhabited these counties, and planted a colony at Colchester. His general, Vespasian, pushed his conquests westwards as far as the Severn. The Britons made a gallant stand under their chief Caractacus, but were utterly defeated, and Caractacus was carried in triumph to Rome, but his life was spared by the emperor. The south of Britain, including London, was now organized as a regular Roman colony; but London, though it was probably even then the chief seat of commerce, was not the capital: Colchester had that honour. In A.D. 61, Queen Boadicea, at the head of her tribes, poured into the Roman colony, and even burned Colchester and London; but Suetonius, the Roman general, defeated her in a great battle; Boadicea committed suicide, and 80,000 of her men were slain. The loss inflicted by them upon their conquerors was by no means contemptible, and shows that the ancient Briton had good stuff in him. In A.D. 78, Agricola pushed his legions west and north, conquering North Wales, and advancing gradually as far north as the Tay, while his fleet explored the coast of Scotland, and sighted Ireland; but it does not appear that they landed there. Agricola was soon after recalled to Rome, and we hear little of events in Britain until the time of the emperor Hadrian.

Caractacus, A.D. 43.

Boadicea, A.D. 61.

GERMAN.

XLIX.

VERBS OF DOUBLE FORM, TRANSITIVE AND INTRANSITIVE.

SOME verbs may be taken in two senses—as performing or undergoing a process—having in one sense a transitive, in the other an in-

transitive meaning. Thus to bake or to roast may mean to perform or to undergo the process of baking. In the first case it is transitive, and is conjugated as a regular verb: Der Bäcker backte das Brod nicht gut, er hat es ſchlecht gebacht, the baker did not bake the bread well, he has baked it badly; Das Brod buk drei Stunden, the bread was baking (undergoing the process) for three hours; Er erſchreckte den Mann durch ſeine Drohungen, he frightened the man with his threats (erſchrecken, erſchreckte, erſchreckt): Er erſchrack bei dieſen Worten, he was frightened at these words (erſchrecken, erſchrack, erſchrocken, to be frightened, to *feel* or endure fear, *neuter*). Thus, in these cases of double verbs, the intransitive form signifies to endure, the transitive to cause a process. These verbs are the following:—

Intransitive and Irregular.

Inf.	Imp.	P. Part.
Backen,	buk,	gebacken, to bake.
Braten,	briet,	gebraten, to roast.
Erſchrecken,	erſchrak,	erſchrocken, to be frightened.
Erlöſchen,	erloſch,	erloſchen, to be quenched, to become extinct.
Schmelzen,	ſchmolz,	geſchmolzen, to melt.
Schweigen,	ſchwieg,	geſchwiegen, to be silent.
Schwellen,	ſchwoll,	geſchwollen, to swell.
Sieden,	ſott,	geſotten, to boil.
Verderben,	verdarb,	verdorben, to be spoiled.
Verwirren,	verworr,	verworren, to be confused.

From the Transitive and Regular Verb

Inf.	Imp.	P. Part.
Backen,	backte,	gebackt, to bake.
Braten,	bratete,	gebratet.
Erſchrecken,	erſchreckte,	erſchreckt, to frighten.
Löſchen,	löſchte,	gelöſcht, to extinguish.
Schmelzen,	ſchmelzte,	geſchmelzt, to melt.
Schweigen,	ſchweigte,	geſchweigt, to silence.
Schwellen,	ſchwellte,	geſchwellt, to cause to swell.
Sieden,	ſiedete,	geſiedet, to boil.
Verderben,	verderbte,	verderbt, to destroy.
Verwirren,	verwirrte,	verwirrt, to confuse.

With regard to these verbs (which should be very carefully committed to memory) Schweigen, to silence, to calm, is now obsolete. The form zum Schweigen bringen, to bring to silence, is now used. The regular form of ſchwellen seldom occurs, though we say: Dieſe neue Unthat ſchwellte die Rechnung, this new crime (evil deed) swelled the reckoning; Der Wind ſchwellte die Segel, the wind swelled the sails, etc. The English word *whirl* is connected with the German wirren or verwirren, to confuse; Mein Kopf iſt ganz verwirrt, my head is quite confused (in a whirl).

Other verbs have a more entirely double form; differing not only in the imperfect and the past participle, but also in the infinitive—thus ſinken, ſank, geſunken, to sink; Er ſank zur Erde nieder, he sank down to the ground (neuter): Er ſenkte den Schatz auf den Grund des Stromes, he sank the treasure to the bottom of the stream (transitive). This will be seen in the following transitive forms and their corresponding intransitives:—

Transitive Verbs.

Beugen, beugte, gebeugt, to bend or bow.
Erſäufen, erſäufte, erſäuft, to drown.
Fällen, fällte, gefällt, to fell.
Flößen, flößte, geflößt, to cause to flow.
Hängen, hängte, gehängt, to hang.
Legen, legte, gelegt, to lay.
Säugen, säugte, geſäugt, to suckle.
Setzen, ſetzte, geſetzt, to get or place.
Sprengen, ſprengte, geſprengt, to burst or blow up.
Stellen, ſtellte, geſtellt, to place.
Stäuben, ſtäubte, geſtäubt, to dust.
Schwemmen, ſchwemmte, geſchwemmt, to cause to swim.
Senken, ſenkte, geſenkt, to sink.
Tränken, tränkte, getränkt, to give drink.
Verſchwenden, verſchwendete, verſchwendet, to waste.
Wägen, wägte, gewägt, to weigh or poise.

Corresponding Intransitives.

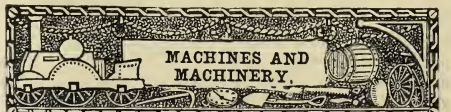
Biegen, bog, gebogen, to bend.
Erſaufen, erſoff, erſoffen, to be drowned.
Fallen, fiel, gefallen, to fall.
Fließen, floß, gefloſſen, to flow.
Hangen, hing, gehangen, to be hung.
Liegen, lag, gelegen, to lie.
Saugen, ſog, geſogen, to suck.
Sitzen, ſaß, geſeſſen, to sit.
Springen, ſprang, geſprungen, to spring.
Stehen, ſtand, geſtanden, to stand.
Stieben, ſtob, geſtoben, to fly, gallop.
Schwimmen, ſchwamm, geſchwommen, to swim.
Sinken, ſank, geſunken, to sink.
Trinken, trank, getrunken, to drink.
Verſchwinden, verſchwand, verſchwunden, to disappear.
Wiegen, wog, gewogen, to weigh (have weight).

The verb flößen, as a transitive, is generally used in the compound form, einflößen, meaning figuratively to *float* an idea into any one's mind. Dieſes Betragen flößte ihm Vertrauen ein, this conduct inspired him with confidence (floated confidence into his mind); Es wird Furcht und nicht Liebe einflößen, it will inspire fear and not love. The verb hangen, hing, gehangen, is more often used in general conversation than hangen for the intransitive form. The verb ſprengen literally means to cause to spring open or to spring up. It is also used in the sense to gallop: „Er ſprengt zu ſeinem Vater,—' Heut zahl ich alte Schuld,'" "He gallops to his father—'To-day I pay the

old debt'" (Uhland's *Döffinger Schlacht*). From the verb ſtieben we have the expression verſtieben, rolled away like dust. Schwemmen = to cause to swim; hence die Überſchwemmung, the inundation. The verb verſchwinden (intransitive) is a compound of ſchwinden, to diminish; verſchwenden, to cause to vanish away by wasteful expenditure. Tränken is used in the sense Die Pferde tränken, to water the horses. Verderben, verderbte, verderbt, the transitive form, is only used in the figurative meaning of degeneracy of morals or character.

Exercise on the Intransitive Verbs, etc., for Translation into German.

An ancient philosopher was accustomed to say, "I have often repented that I have spoken, but never that I have been silent." William the Silent, Prince of Orange, the liberator of Holland from the tyranny of Philip II. of Spain, won his honourable surname thereby (dadurch), that he was often silent where others through unconsidered words came into great danger. The heat was so great at the burning of Moscow, in 1812, that the lead from the roof of the palace melted and flowed down in streams; and many lost their lives in this terrible fire. All attempts to extinguish the flames were in vain. The French soldiers ran out of the town, and the cavalry galloped away in haste. They were obliged to lie in the fields, until the fire after some days became quenched (erlöſchen) by itself. Last year the harvest was almost spoiled by the rain, which poured down every day, for months (months long). In some districts the water carried (ſchwemmen) even trees of high growth away; and drowned many oxen and sheep. The corn lay for weeks in the fields, and could not be carried home because it was so wet. It spoiled in the fields, and the hope of the farmer for the year was lost. In some places the rivers swelled so that it was impossible, at the usual ferries, to set the people across. Many were frightened at the aspect of the rushing stream, whose condition inspired the idea of insecurity, and might even bend (beugen) a firm courage. The Romans felled the trees in the forests of Britain, and scattered (aus einander ſprengen) the bands of the natives who had there found shelter. Brave, but without discipline, the Britons could not stand against the legions of the warlike strangers, who at last bent the whole land beneath their yoke. It is well to weigh the consequences of an action; many a good thing has been spoilt by over-hurry. "Hasten with deliberation," says the proverb. This general confused the whole plan of the king, through his want of ability to understand it. The Loire flows through (the) western France. At the mouth of this river lies the great and important town (of) Nantes. When Gustavus Adolphus, at the battle of Lützen, was galloping across the field, he was shot from his horse by an imperialist. He sank on the ground, and said to his companion: "I have enough, brother; save thyself." Immediately afterwards the imperial cavalry rushed (ſtieben) across the field, and the king's corpse was crushed under the feet of the horses. The heathen inhabitants of North Germany could not be converted to Christianity until the monk Winfred, afterwards called Bonifacius, had felled with the axe the holy oaks which they looked upon as the emblems of their faith, and adored as such. The Queen Christina of Sweden, the only daughter of Gustavus Adolphus, laid down her crown in favour of her cousin; and one says that she afterwards in secret repented this act her whole life long. The wish to gain a powerful ally weighed more with the Empress Maria Theresa than the thought of the old enmity between Austria and France; she wished to destroy the power of Frederick the Great, and thought to be able to do this, because it lay in her power to win Louis XV. Over the head of Damocles, a flatterer of the tyrant Dionysius, hung a naked sword; and this danger was enough to confuse him in such a degree that he begged Dionysius to let him rule no longer. The sword has hung for three months on the nail. In many battles the blood of the valiant Germans flowed to win the rule of Italy for their emperors. But the might of the Germans in Italy sank with the fortune of the house of the Hoheustauffen. Frederick I., called Barbarossa or the Redbeard, the mightiest emperor (out) of that house, was drowned in the river Calicadnus, in Syria. It was in the third Crusade. The plant sucked nourishment from the earth and grew high and strong. Bent by the wind, it still maintained itself, until after a great storm it lay uprooted on the ground. After he had drunk from the poison goblet, Socrates laid himself down, and talked cheerfully with his friends. "Oh that thou shouldst die innocent, Socrates!" cried one of them. "How!" replied the sage, "wouldst thou rather that I should die guilty?" (Let) each man see that he stand fast where fate and duty have placed him. When he was in danger to be taken prisoner by his enemies, the emperor Otto sprang into the water, and swam towards a boat wherein some of his friends sat. Thus he saved himself out of the foe's hand.



IX.

Pressing Machinery.

Of all the methods of producing pressure, the simplest is by the direct application of a weight. The pressure of one's hand upon a table is due merely to our supporting a part of our body by that hand; so that the maximum vertical pressure that can be produced by a man without the aid of machinery must be equal to the weight of his body, and no more. But if the man is supplied with suitable apparatus, we shall subsequently see that his power becomes theoretically unlimited.

Where it is required to produce pressure over

a large surface, but not simultaneously, as in making roads or garden paths, it is most convenient to pass a heavy roller over that surface. Garden rollers are light enough to be drawn by hand; but as it is the mere weight of the roller that produces the pressure, it is necessary in making macadamized roads to employ rollers that require from six to ten horses to draw them. The *steam roller* is still heavier, and is really a combination of three rollers arranged in a similar way to the three wheels of a perambulator. The steam engine has nothing whatever to do with the production of the pressure, except so far as its own weight is concerned, but merely moves the apparatus along.

The ordinary *mangle* used for pressing the creases out of linen, clothes, etc., consists of a large wooden box filled with stones to give it the necessary weight, which is moved backwards and forwards on two rollers that rest on a smooth surface of wood suitably supported. The motion of the box of stones is obtained by turning the handle first in one direction and then in the other, unless the mangle is supplied with the mechanical contrivance called the "mangle-wheel motion," for a description of which the reader is referred to any elementary work on mechanics.

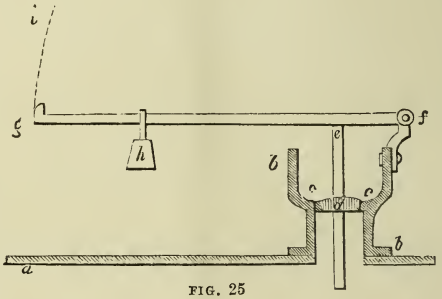


FIG. 25

The mere application of weight is a very cumbersome method of producing pressure, and hence devices are employed for, so to speak, magnifying it. Thus, in the ordinary safety valve, a comparatively small weight is made to produce a greatly increased pressure by the use of a lever. The nearer the weight *h* (see fig. 25) is made to approach the free end of the lever marked *g*, the greater is the pressure produced on the valve spindle *e*. The use of the lever in this case, and in many others that will be treated of, is a very important one. But it cannot be too carefully borne in mind that no machine can create power, and that the lever merely serves to *concentrate* the available force. With nutcrackers we can easily crush what our unaided fingers could make no impression upon, not because they give us any additional power or lessen the total resistance to be overcome, but because they enable the resistance to be overcome more gradually.

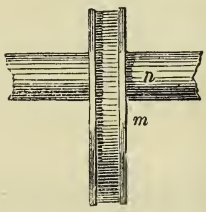


FIG. 26.

But by far the greater number of pressing machines owe their efficacy to the use of the wedge or its modification the screw. The application of the simple wedge for pressing purposes is seen in the use of printers' chases, —that is, iron frames into which the type is so tightly held by wedges or quoins that it may be lifted as if it were but a single mass of metal. A form of copying-press is in common use in which a circular wedge or "cam" is employed for producing the necessary pressure. The principle of this apparatus will be understood on referring to fig. 26. The wheel *m* is an eccentric, as its axis does not pass through its centre. If the shaft on which the wheel works is kept stationary, it is obvious that by turning the wheel through half a revolution there will be a considerable increase of the space below the wheel, and if, while it is in this position, anything is brought into contact with the edge of the wheel, the next half revolution will push it downwards through a distance that will be twice as great as the distance between the centre of the axle and the centre of the wheel. As only half a revolution is necessary to produce the maximum pressure, it is only necessary to use one-half of the edge of the wheel, and it is convenient to attach to the other half a long handle which serves as a lever to concentrate the force used in turning it. A similar contrivance, but on a much larger scale, is used in iron-works for squeezing the "blooms" of half-melted metal. The range of pressing power that can be obtained by means of such an apparatus is very limited, and this drawback is overcome by the use of a continuous wedge or screw.

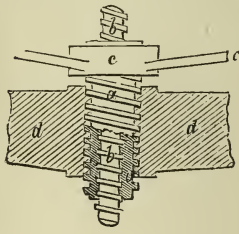


FIG. 27.

Common screw presses are so familiar that it is unnecessary to enter into the principles or the practice of their use. Every one knows the screw-form of copying-press. Each turn of the handle pushes the upper plate downwards through a distance equal to the pitch of the screw, so that for any given number of turns the movement of the plate is greater with a coarse screw than with a fine one. It is the nature of the screw that constitutes the radical difference between the machines of this class. Where the pressure must be so sudden that it may be compared to the blow of a hammer, the screw is so coarse or steep that half a revolution is sufficient to drive the die that is fastened to the lower end of it downwards some two or three inches. The force with which the die strikes is increased by attaching a heavy wheel to the top of the screw, which serves by its inertia to concentrate the power of the operator.

But if instead of a pressure that by reason of its suddenness may almost be called a blow, we require a pressure that must be powerful but very gradually applied, then a screw is required with a thread that makes several turns to the inch. But we soon find a practical limit here, because the more turns there are in a given space, the thinner must be the projecting parts of the screw, and thinness means weakness. This difficulty is overcome by the use of the "differential screw," which is really a combination of two screws, the threads of which differ in pitch, and are so arranged that the downward motion obtained is equal to this difference. In fig. 27 the central screw marked *b* works exactly as in ordinary presses, and by its means a fairly rapid movement of the upper plate is obtained. But if we turn the nut *c a*, that the screw *b* works in, in the opposite direction, the screw *b* will be thrust downwards as before, but at the same time the nut that it works in will be raising itself, and consequently *b*, by reason of the thread *a* that works in *d*. It will be observed that the pitch of the screw *a* is less than that of *b*, so that by turning *ac*, *b* will be pushed downwards through a greater distance by its own thread than it will be drawn up by the thread on the outside of *a*. The resultant motion is therefore equal to the difference between the pitch of the threads *a* and *b*, and it is obvious that this difference may be reduced to any extent without weakening any of the parts of the apparatus.

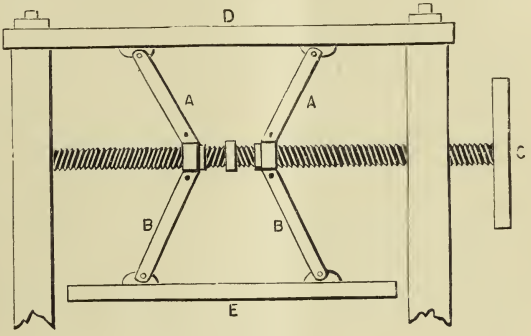


FIG. 28.

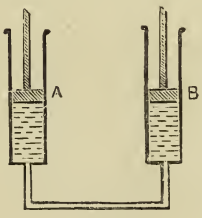


FIG. 29.

Another method of producing pressure is by the use of what is called a toggle-joint; and this, though an old contrivance, has latterly come extensively into use. The presses made on this principle are really lever presses worked by screws. Thus in the diagram (fig. 28) A and B are parts of bent rods, which by the rotation of the double screw C tend to become straightened, and therefore longer. They are fixed by joints to the stationary head D and to the movable plate E, which last is consequently pushed down and produces pressure on whatever is placed below it.

When a very considerable pressure is required, recourse must be had to the *hydraulic press*. The principle of its action is very simple. If two cylinders are arranged as in fig. 29, the parts below the pistons being filled with water, it is obvious that by pressing down one of the piston rods through a certain distance, the pressure will be transmitted by the water to the other piston, which will thus be raised through an equal distance. Or if equal weights are secured to each piston rod, they would balance one another, and there would be no movement of either piston. But if the area of the under surface of the piston *a* were reduced until it was equal to only half that of *b*, the cylinder *a* being also reduced, we should then find that any weight on *b* would require only one-half its weight on *a* to balance it. Or if the cylinder *a*, with its piston, were reduced until its sectional area was equal to one-hundredth of that of *b*, we should then find that 100 lb. on *b* would be perfectly supported by a weight of 1 lb. on *a*; or, in other words, a pressure of 1 lb. on *a* would produce a pressure equal to 100 lb. on *b*. Thus the pressure is directly proportional to the sectional area of the cylinders. Here again it may be remarked that there is no creation of power, but only a concentration of it; for although in the last instance the 1 lb. balances the 100 lb., if we add to the 1 lb., so making it raise the 100 lb., we shall find that the heavier weight moves upwards through only one-hundredth the distance that is traversed by the lighter weight, thus the same force is required to raise 1 lb. through 100 in. as to raise 100 lb. through 1 in.

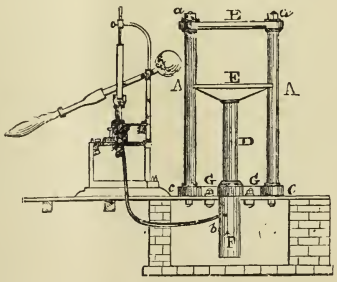


FIG. 30.

The essential parts of the hydraulic press are a pair of unequal-sized cylinders, the smaller one being arranged with valves as a pump, so that its plunger when raised draws more water into the apparatus instead of drawing back the water that it has forced into the larger cylinder.

A common form of hydraulic press is shown in fig. 30. F is the larger cylinder, D the *ram* that works up and down in it, and B the pipe through which the water is driven by the pump into F. The object to be pressed is introduced between E and B.

XLV.

THE VERB (*continued*).—THEORY.

Practical Application.

(1) VOCABULARY XXII.

Etymologique : Transmutation du *W* en *g* ou en *gu*.

(*Cases where an original* w *has given* g *or* gu *in French.*)

gâcher, *to wet*, fig. *to bungle;* from old high German WASKAN, to wash.
- le gâche, *mason's tool for stirring mortar.*
- la gâcheur, *mortar-stirrer, gauger, bungler.*
- gâcheux (se), adj., *soaked, muddy.*
- le gâchis, *mortar, liquid mud, mess.*
- le gâchoir, *potter's box for mixing materials.*

gager, *to wager, to hire, to pay;* fr. O.H.G. WETTI, or low Latin VADIUM, WADIUM, a pledge (*vadiare*).
- le gage, *pledge, forfeit;* les gages, *wages.* [*domestic.*
- le gagiste, *a servant, other than* la gagerie, *distress on furniture* (saisie-gagerie).
- la gageure (§ 37, Rem., p. 187, vol. i.), *wager.*
- engager, *to engage, pledge, hire, press, etc.*
- engagement, ——, *enlistment, pledging.*
- dégager, *to release, clear, ease.*
- dégagement, *clearing;* escalier de dégagement, *back-stair.*

gagner, *to earn, to get, to obtain, to gain, etc.;* fr. O. H. G. WEIDA, a pasture, WAIDANJAN; L. L. WEIDANIARE.
- le gagnage, *pasture-land.*
- le gagne-denier, *odd job man;* le gagne-petit, *knife-grinder;* le gagne-pain, *a livelihood.*
- le gain, *profit, advantage.*
- regagner, *to regain.* [*math.*
- le regain, *return* (*of health*), *after-*

gant, *a glove*, fr. L. L. *wantus*
- ganter, *to fit;* se ganter, *to put gloves on.* [*glove-maker.*
- la ganterie, *glove trade;* gantier,
- la gantelée, *foxglove.*
- le gantelet, *gauntlet.*
- se déganter, *to take off one's gloves.*

garantir, *to guarantee, to warrant;* fr. L. L. WARANTUS; O. H. G. WERÊN, *to furnish*
- le garant, *guarantee, warrant, surety.*
- la garantie, *guarantee, warranting, safeguard;* bureau de g., *assay office.*

garder, *to guard, to keep, etc.;* fr. O. H. G. WARTÊN, *to watch over*
- la garde, *guard, care, ward, etc.*
- le garde, *guardsman, etc.*
- le gardeur de cochons, *swineherd;* la gardeuse de dindons, *turkey herd girl.*
- le gardien, *guardian, keeper, watchman, etc.* [*look.*
- le regard, *a look;* regarder, *to*

garer, *to shunt, to dock, get out of the way*, fr. O. H. G. WARON, *to take care.*
- la gare, *river-basin, railway-platform, terminus.*
- gare! *look out! take care!*
- la garenne, *the warren.*
- le garennier, *keeper of a warren.*
- égarer, *to mislead, to mislay.*
- l'égarement, *error, fault, mistake, wandering.*

garnir, *to furnish, adorn, stuff, fill, rig, garnish*, fr. O. H. G. WARNÔN, same root WAR, as in *garder* and *garer*, above
- le garnement, *blackguard.*
- le garni, *furnished lodgings.*
- le garnisaire, *bailiff, soldier billeted to punish.*
- la garnison, *garrison.*
- la garniture, *trimming, lining.*
- dégarnir, *to strip, to dismantle.*
- regarnir, *to furnish, to trim again.*

gâter, *to spoil, to waste*, fr. O. H. G. WASTJAN, *to ravage*
- un gâte-enfant, *child spoiler;* un gâte-métier, *trade ruiner;* un gâte-sauce, *bad cook.*
- gâterie, *over-petting, spoiling.*
- dégât, *devastation, waste, ravage.*

gâteau, *a cake*, fr. O. H. G. WASTEL, same root as WASTJAN, above.

gauche, *left side, awkward, clumsy*, fr. O. H. G. WELK, *weak*
- gaucher, *left-handed.*
- la gaucherie, *awkwardness*

gauchir, *to become warped, turn aside*, fr. O. H. G. WANKJAN, *to yield*
- le gauchissement, *warping, twisting*

gaude, *wild mignonette*, fr. G. WAUDE.

gaufre, *honeycomb, wafer, waffle*, fr. G. WAFFEL
- gaufrer, *to goffer, emboss.*
- le gaufrier, *iron instrument for making waffles.*
- le gaufreur,-euse, *a stuff stamper*
- la gaufrure, *goffering, embossing,*
- le gaufroir, *instrument for stamping stuffs, the stamp.*

gaule, *a long pole, a switch*, fr. Frieslandish WALU, *a stick;* or Breton GWALEN, *a wand*
- la gaulade, *a beating with sticks.*
- le gaulage, *the act or result of knocking off.* [*tree.*
- gauler, *to knock off fruit from a*
- la gaulette, *small pole.*
- le gaulis, *underwood.*

les Gaules, *Gaul, France*, fr. L. GALLIA, fr. G. WALH OR WALHLA, *barbarian*
- gaulois, *Gallic, Gaulish, merry.*
- Galles, *Wales.*
- gallois, *Welsh.*

Gautier corresponding to WALTER.

gazon, *turf, sward*, fr. O. H. G. WASO
- gazonner, *to lay with turf*
- le gazonnement, *laying with turf*

gibelin, *a Ghibelline*, fr. G. WEIBELINGEN (Conrad von).

gué, *a ford;* fr. O. H. G. WAT, *a ford, where one may wade*
- guéable, *fordable.*
- guéer, *to ford.*

guède, *woad*, fr. O. H. G. WEIT
- guèder, *to dye with woad*

guelphe, *a Guelph*, fr. G. WELF.

guêpe, *a wasp*, fr. O. H. G. WAFSA, or L. VESPA
- guêpier, *wasps' nest;* fig. *hornets' nest.* [*species of mushroom.*
- guêpier, *a bird, bee-eater;* also *a*

guère, *much;* fr. O. H. G. WEIGARO, *much*
- guères, *much* (in poetry only)
- naguère, *not long since; formerly.*

guérir, *to cure*, fr. O. H. G. WERJAN, *to defend*
- la guérison, *recovery.*
- guérissable, *curable.*

guerre, *war*, fr. O. H. G. WERRA, *a quarrel*
- le guerrier, *warrior;* adj. *warlike.*
- guerroyer, *to wage war.*
- guerroyeur, *regular warrior.*
- aguerrir, *to train for war.*

guetter, *to watch*, fr. O. H. G. WAHTAN
- le guet, *watch;* guet-appens, *ambush.*
- le guetteur, *watchman.*
- aguets, *watch:* être aux aguets, *to be on the watch.*

guichet, *wicket*, fr. Walloon WICHET
- guichetier, *turnkey, door-keeper.*

Guillaume corresponding to WILLIAM.

guimpe, *a wimple*, fr. O. H. G. WIMPOL, *a summer dress.*

guinder, *to hoist, to strain*, fr. O. H. G. *windan*
- la guinderesse, *mast-rope.*
- le guindage, *hoisting.* [*flag.*
- le guindant, *the fastened side of*

guipure, *lace*, fr. O. H. G. WÊBAN, *to weave.*

guise, *manner, way, wise*, fr. O. H. G. WISA, *manner*
- déguiser, *to disguise.*
- le déguisement, *disguise.*

Guyot, corresponding to WYATT.

EXERCISE LV.

1. Attendez-moi sous l'orme (*under the elm-tree*) se dit d'un rendez-vous où l'on n'a pas dessein d'aller, d'une chose que l'on ne veut pas faire (Littré.—*an appointment one does*

not intend to keep, of something that one does not wish to do). 2. L'erreur la plus pernicieuse est de nous attendre que Dieu (*God*) nous attendra (Bourdaloue). 3. Le roi après (*after*) avoir parlé à quelques-uns (*some of them*) avise enfin ce chapeau gris (Saint-Simon—*at last that grey hat*). 4. Hors (*with the exception of*) vous et moi, monsieur, je ne crois pas que personne (*I do not think that any one*) s'avise de courir maintenant les rues (Molière—*to run about the streets at this time*). 5. Battons le fer pendant qu'il est chaud (*iron while it is hot*). 6. Il s'est battu plusieurs fois (*several times*) en duel. Que de fois (*how often*) les Guelphes et les Gibelins se sont battus ! 7. Ne vous confessez pas au renard, n'allez pas découvrir (*do not go and reveal*) vos sentiments à une personne qui en fera son profit (*who will make his profit out of them*). 8. Il ne faut (*one should not*) défier un fou (*mad fellow*). 9. Vous, favori ! vous, grand ! défiez-vous des rois ; leur faveur est glissante (*slippery*), on s'y trompe (La Fontaine—*one cannot rely upon it*). Thésée (*Theseus*) est mort (*dead*), madame, et vous seule (*alone*) en doutez (Racine). 11. Je m'en doutais, seigneur, que ma couronne (*my lord, that my crown*) vous charmait du moins autant (*at least as much*) que ma personne (Corneille). 12. Emballez avec tous vos dieux (*all your gods*) Flore et l'Aurore aux doigts de rose (Béranger—*pink-fingered Aurora*). 13. Qui sait (*knows how to*) faire sa cour se fait aux mœurs (*to the morals*) des princes (Corneille). 14. Mazarin aimait naturellement le jeu (*naturally, gambling*) ; mais il ne jouait que pour s'enrichir (*only to enrich himself*), et trompait (*to cheat*) tant qu'il pouvait pour (*as much as he could for the purpose of*) gagner. 15. On voyait même dans les pâturages (*one even saw on the grazing grounds*), les loups se jouer au milieu des moutons (Fénelon—*in the midst of the sheep*). 16. Si vous saviez ce que c'est que de (*if you knew what it is to*) marier son fils, vous m'excuseriez d'avoir été si longtemps sans vous écrire (Mme de Sévigné—*so long without writing*). 17. Mariez-vous, ma sœur, à la philosophie (Molière). 18. Voilà ce que c'est que de (*this comes from*) se mettre en personne de qualité (Molière—*as a man of quality*). 19. Ceux qui (*those who*) admiraient sa fermeté perdirent (*fortitude, lost*) la leur ; ceux qui la plaignaient (*imperfect of* plaindre) paraissaient presque les seuls à (*almost appeared the only ones to be*) plaindre (Fléchier). 20. L'esprit d'impiété (*spirit of infidelity*) se rit de tout ce qu'il y a de plus sacré (Pascal—*all what is most sacred*).

EXERCISE LVI.

1. William says (*dit qu'*) it has drizzled the whole (*tout le*) day; did it also drizzle (*perfect indefinite*) the whole (*toute la*) evening? 2. Walter says that it hails as-often-in (*aussi souvent en*) England as (*qu'*) in France : is it true (—*ce vrai*)? 3. In England it hails most in (*en*) winter, and in France it hails most in (*en*) spring ; otherwise (*autrement*) there is not a great difference between the two countries (*grande différence entre les deux pays*). 4. When it thundered (*imperfect indicative*) Mme de Saint-Hérem would creep (*se fourrer, imperfect indicative*) on all fours under some sofa (*à quatre pattes sous un lit de repos.*—Saint-Simon). 5. Let it (*that it may*) snow, hail, or thunder, little-matters-to-him (*peu lui importe*). 6. Is it cold out of doors? I should think so (*dehors? Je crois bien*) ; the frost is exceeding hard (*it freezes to split-stones = à pierrefendre*). 7. It has been freezing (*present indicative*) in (*à*) Paris for-nearly (*depuis près de*) eight days. 8. You were wrong (*se tromper*) in supposing that (*en supposant qu'*) it did never snow in Athens (*imperfect indicative—à Athènes*) ; there fell there more than a foot of snow last winter (*il y est tombé plus d'un pied de neige l'hiver dernier*). 9. We were starving (*se morfondre*) more than we ever did in (*plus que nous ne l'avons jamais fait en*) Prussia ; you may guess (*vous pouvez bien deviner*) that there were neither fireplaces, nor hot-air stoves, nor even common stoves (*imperfect indicative—ni cheminées, ni calorifères, ni poêles même*). 10. The ice, the snow is melting (*les glaces, les neiges fondent*), it has been thawing since this morning (*present indicative—depuis ce matin*). 11. You hope (*espérer*) that it will thaw; I (see p. 199) hope (that) it will freeze, and (that it will) freeze very hard indeed (even to stone splitting) 12. When your pleasures (*plaisirs*) are at stake you-care-for-nothing-else (*tout le reste vous est égal*). 13. You are mistaken ; your fortune is not at stake, it is your honour. 14. If my honour were really at stake (*imperfect indicative—réellement*) I should care for nothing else (*me serait*). 15. As his fortune will be at stake, he-will-be-careful (*il fera attention*). 16. There are laws for the society of (*lois pour la société des*) bees : how has one been able to think (*comment a-t-on pu penser*) that there were none for the society of men? 17. You were right (*perfect indefinite*) to get angry (*de vous pêcher*) ; there was (*imperfect*) cause-for-it (*de quoi*). 18. The best peaches come from Montreuil. Which Montreuil do you mean (*de quel M.—is at stake*)? There are three or four Montreuils in France. I mean (*= there is at stake*) Montreuil near (*près de*) Paris. 19. How is the weather? is it not foggy?—No, it is fair.—Do you think it will keep up (*croyez-vous qu'il restera au beau*)?—I doubt (of) it. 20. Is it not better, as Voltaire has it (*comme le dit V.*) to-have-pains rather-than-remorse (*avoir des douleurs que des remords*)?

XI.

LIGHT (*continued*).

THE investigation of the manner in which images are formed by spherical mirrors is somewhat more complicated than the consideration of the formation of images by plane mirrors, but with a

Concave mirrors.

little care the phenomena of reflexion exhibited by concave and convex mirrors will be readily understood. We will first consider the formation of images by a concave mirror. A concave mirror is a very small segment of a hollow sphere, and its internal surface is used for reflexion.

Before investigating the formation of images by such a mirror we must define one or two technical terms which we shall have to employ. The centre of the sphere of which the mirror forms a part is termed the *centre of curvature*; a line drawn through the centre of curvature to the middle point of the surface of the mirror is termed the *principal axis*; any other straight line drawn through the centre of curvature to the mirror is termed a *secondary axis*; the point on the principal axis where the reflected rays which fall on the mirror parallel to this

Principal axis and focus.

FIG. 51.

axis cross each other is termed the *principal focus*; the angle formed by drawing lines from two diametrically opposite points of the mirror to the centre of curvature is termed the *aperture* of the mirror. In fig. 51 these terms are illustrated: *c* is the centre of curvature, C A the principal axis, F the principal focus. The following statements concerning the formation of images by spherical mirrors are *absolutely* true only of parabolic mirrors, but when the spherical mirror is of but slight curvature they are sufficiently true for all practical purposes.

Rays of light coming from an infinite distance, or from a distance such as that of the sun, sufficiently great to render them sensibly parallel, after falling upon the mirror, are reflected by it so as to intersect each other at a point on the principal axis, midway between the centre of curvature and the mirror; this point is termed the focus of parallel rays, or the *principal focus*. Rays of light coming from a point on the principal axis of the mirror beyond the centre of curvature, are, after reflexion, brought to a focus at some point between the centre of curvature and the principal focus. Rays of light coming from a point between the centre of curvature and the principal focus are brought to a focus at some point beyond the centre of curvature.

Focus for parallel rays.

In all spherical mirrors the positions of the object and the image are interchangeable—that is to say, if a point of light be placed at the principal focus, the rays from it will be reflected parallel to the principal focus; if the point of light be placed between the centre of curvature and the principal focus, its image will appear at some point beyond the centre of curvature; if now the light be transferred to the point where its image appears, the image will immediately shift to the position recently occupied by the light. The foci of spherical mirrors are therefore said to be *conjugate foci*. If the luminous point be placed between the principal focus and the mirror, the rays of light are no longer brought to a focus in front of the mirror, but they, after reflexion, diverge; their direction, however, may be traced backwards, and they will be found to intersect in a point on the principal focus, *behind* the mirror; an image will therefore be seen apparently *in* the mirror.

Conjugate foci.

It will be seen from the foregoing paragraphs that the images formed by concave mirrors differ from each other in character. Those which are formed in front of the mirror are formed in the air, and can be actually seen by an observer, or can be received upon a screen; such images are therefore termed *real images*. The images seen *in* the mirror when the object is between it and the principal focus are obviously only apparent, and are therefore termed *virtual images*. It is evident that the images formed by plane mirrors are always virtual.

Real and virtual images.

The formation of images by spherical mirrors may seem at first sight to differ in principle from their formation by plane mirrors, but upon examination the same great law of reflexion will be found to govern the formation of both kinds of images alike. It must be remembered that the perpendicular, or, as it is termed, the *normal*, to any point on the surface of a spherical mirror is a straight line drawn from that point to the centre of curvature, and if we determine the angle at which any particular ray strikes the mirror, its reflected ray is at once determined in the ordinary manner by the law of reflexion—that is, it will

Application of the law of reflexion.

FIG. 52.

make the same angle with the normal as does the incident ray, and will be, of course, upon the opposite side of it. Fig. 52 will assist to make this more clear. Let S be a luminous point upon the principal axis and beyond the centre of curvature; the rays of light from it will proceed as a diverging cone towards the mirror. Take the lower outside ray of this cone, and let the dotted line through C be the normal to the surface of the mirror; the direction of the reflected ray is determined by drawing a line on the other side of the normal, and making with it the same angle as that made by the incident ray. This ray will cut the principal focus in *s*, and if each ray of the

cone be treated in a similar manner it will be found that the reflected rays will all meet at the point *s*, which is therefore the focus of the luminous body, S, and this conclusion is verified by experiment. If now S be slowly moved towards the mirror, the focus, *s*, will move from the mirror to meet it, until, when the point C is reached, image and object will coincide in position. As the luminous point continues to move towards the mirror the image moves from it, and when the former reaches *s* the latter

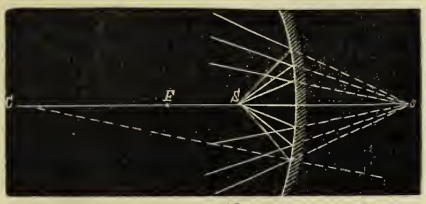


FIG. 52.

will reach S—that is, *the object and the image have exchanged places.* Continuing to move the luminous point towards the mirror, the image still further recedes from it, until when the point F is reached the reflected rays no longer form a focus, but are parallel to each other (see fig. 51). In all these positions of the object the position of the image, as detailed above, can be demonstrated geometrically by the same simple plan, and fig. 53 shows how the formation of a virtual focus, when *s* is between F and the mirror, can be deduced.

The rays of light from S fall as a widely-diverging cone upon the mirror, and if the lower and outer ray of this cone be considered in connection with the dotted line through C representing the normal, it is obvious that the reflected ray will still more widely diverge; and if each ray be treated in the same manner it will be seen that the reflected rays form a cone which is still more widely divergent than that of the incident rays, and the former will therefore not meet in front of the mirror at all. If, however, the reflected rays be produced backwards they will meet in a point, S, upon the principal axis, and there form a virtual focus.

Formation of virtual focus.

We have already defined a secondary axis of a spherical mirror, and it will therefore be sufficient here to remind our readers that everything which has been said concerning the reflexion of rays of light coming from points on the principal axis is relatively true of the reflexion of rays on any secondary axis. By means of secondary axes we can determine the formation of images of objects having a distinct superficies, not being mere geometrical points.

Secondary axes.

In fig. 54 let A B be an object in front of a concave mirror and beyond the centre of curvature. Draw from A and B lines to the surface of the mirror passing through C; these will be secondary axes. All the rays which diverge from A will be brought to a focus at the conjugate focus, *a*. Draw from A and B straight lines parallel to the principal axis and meeting the mirror. Now these lines represent-

Formation of images by concave mirrors.

ing rays parallel to the principal axis, the reflected rays must pass through the principal focus, F; draw lines from the points where these rays meet the mirror through F to the respective secondary axes, which they will meet in *a* and *b*. This simple construction obviously gives us the position of the image, and it will be found to be *inverted and diminished.* If *a b* be the object A B will be the image, which in this case will be *inverted and enlarged.* Spherical mirrors are incapable of bringing all the rays which fall upon them to a common focus, and this inability is known as *spherical aberration.*

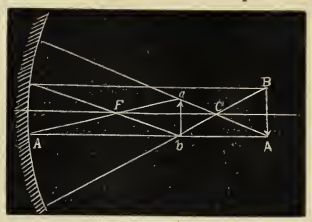


FIG. 54.

Spherical aberration.

All the facts described in this chapter concerning either concave or convex mirrors can be verified by the reader himself by numerous experiments; failing perfect spherical mirrors the inside and outside of a well-polished gravy spoon will approximately answer the purpose, or a couple of watch-glasses blacked in the one

Experimental illustrations.

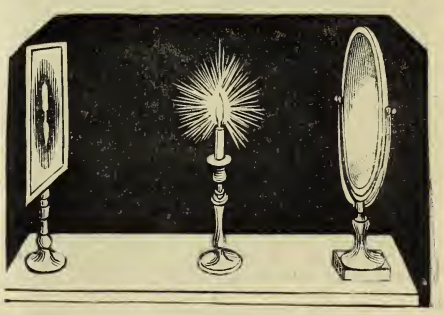


FIG. 55.

case outside, in the other inside. In fig. 55 is represented an experiment with a candle-flame, by which the facts detailed above with regard to concave mirrors may be verified. By placing the candle and screen in different positions all that has been said concerning formation of images, conjugate foci, etc., may be experimentally proved.

When images formed by a concave mirror are received upon a screen, what has been said above as to their positions is true, but when they are viewed by an observer directly the position varies somewhat with the position of the observer's eye. This will be understood from fig. 56. The plane of the figure contains the principal axis of a concave hemispherical mirror, and the incident rays are parallel to the principal axis. All the rays which are reflected by the plane of the figure touch a curve which has a cusp at F, and this curve is termed a *caustic curve.* The position in which an object is seen is determined by drawing a tangent to this curve; if the eye

Caustics.

be at E the point of contact of the tangent with the curve will be at F, but if the eye be at E′,

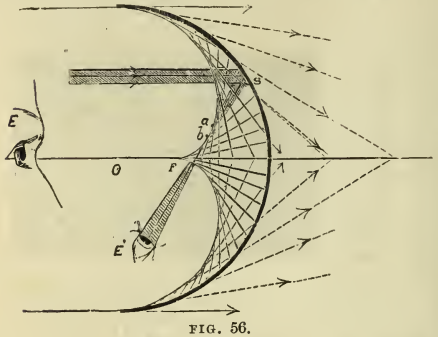


FIG. 56.

the point of contact will be at *a*, which lies out of the direction of F. A caustic curve can often be seen on the surface of milk in a cup which reflects the light of a candle from the inside.

Virtual image in concave mirrors.

If an object be placed in front of a concave mirror between the principal focus and the mirror, the image formed will be, as we have already shown in the case of a luminous point, a virtual one; it will also be erect and enlarged. The construction to determine the

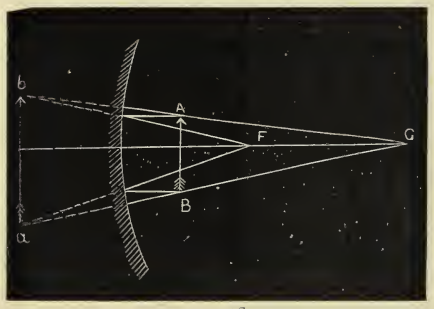


FIG. 57.

formation of these virtual images is shown in fig. 57, where AB is the object and *a b* the virtual image.

ALGEBRA.

X.

SIMULTANEOUS SIMPLE EQUATIONS (*continued*).

ALL the rules already given for clearing simple equations of fractions apply to simultaneous equations. It is always necessary before applying the rules for solution given above to simplify simultaneous equations as much as possible. Thus, let it be required to solve the equations:

$$\frac{x-2}{5}-\frac{10-x}{3}=\frac{y-10}{4},$$

$$\text{and } \frac{2y+4}{3}-\frac{2x+y}{5}=\frac{x+13}{4}.$$

We must first clear of fractions. For this purpose multiply the first equation by 60, and we get—

$$12x-24-200+20x=15y-150;$$

and this, being simplified, becomes

$$32x-15y=74.$$

Multiply the second equation by 24, and we get—

$$16y+32-6x-3y=6x+78,$$

which becomes

$$13y-12x=46.$$

We have then only to solve the equations—

$$32x-15y=74, \text{ and } 13y-12x=46.$$

Multiply the first of these by 3 and the second by 8, and add. The value of y will be found to be 10. Then by substitution x is found to be 7.

Solve the following simultaneous equations:

1. $7x+10y=41$, and $13x-17y=17$.
   Ans. $x=3$; $y=2$.
2. $\frac{x+2}{4}+\frac{y-x}{4}=2x-8$, and $\frac{2y-3x}{3}+2y=3x+4$.
   Ans. $x=5$; $y=9$.
3. $\left.\begin{aligned} 8x-3y&=19+\frac{7x+1}{8}\\ 3x-5y&=18-\frac{13y-3}{11}\end{aligned}\right\}$.
   Ans. $x=1$; $y=4$.
4. $\left.\begin{aligned} 5x+4y&=58\\ 3x+7y&=67\end{aligned}\right\}$.
   Ans. $x=6$; $y=7$.
5. $\left.\begin{aligned} 11x+3y&=100\\ 4x-7y&=4\end{aligned}\right\}$.
   Ans. $x=8$; $y=4$.
6. $\left.\begin{aligned} \frac{x}{2}+\frac{y}{3}&=7\\ \frac{x}{3}+\frac{y}{2}&=8\end{aligned}\right\}$.
   Ans. $x=6$; $y=12$.
7. $\left.\begin{aligned} \frac{x}{7}+7y&=99\\ \frac{y}{7}+7x&=51\end{aligned}\right\}$.
   Ans. $x=7$; $y=14$.
8. $\left.\begin{aligned} \frac{x+2}{3}+8y&=31\\ \frac{y+5}{4}+10x&=192\end{aligned}\right\}$.
   Ans. $x=19$; $y=3$.
9. $\left.\begin{aligned} \frac{2x-y}{2}+14&=18\\ \frac{2y+x}{3}+16&=19\end{aligned}\right\}$.
   Ans. $x=5$; $y=2$.
10. $\left.\begin{aligned} \frac{2x+3y}{6}+\frac{x}{3}&=8\\ \frac{7y-3y}{2}-y&=11\end{aligned}\right\}$.
    Ans. $x=6$; $y=8$.
11. $\left.\begin{aligned} 3x+\frac{7y}{2}&=22\\ 11y-\frac{2x}{5}&=2a\end{aligned}\right\}$.
    Ans. $x=5$; $y=2$.
12. If $x+1 : y :: 5 : 3$, and $\frac{2x}{3}-\frac{5-y}{2}=\frac{41}{12}-\frac{2x-1}{4}$, find the values of x and y.
    Ans. $x=4$; $y=5$.

13. $x : 3y :: 4 : 7$
$\frac{2y}{18} - \frac{8x-2}{50} = 1 - \frac{4+y}{3} + \frac{x-y}{6}$

Ans. $x=12$; $y=7$.

14. $\frac{19-x}{9} : 5x - \frac{14+y}{5} :: 1 : 8$
$1 + \frac{25+5y}{6} - \frac{7x-6}{3} = 10 - \frac{3x-10+7y}{12}$

Ans. $x=3$; $y=7$.

15. $\frac{4x}{x^2} + \frac{5y}{y^2} = \frac{9}{y} - 1$
$\frac{5}{x} + \frac{4}{y} = \frac{7}{x} + \frac{3}{2}$

Ans. $x=4$; $y=2$.

16. $ax + by = m$
$cx + dy = n$

Ans. $x = \frac{md-n}{ad-bc}$
$y = \frac{na-m}{ad-bc}$.

17. $\frac{a}{x} + \frac{b}{y} = m$
$\frac{c}{x} + \frac{d}{y} = n$

Ans. $x = \frac{bc-ad}{nb-md}$
$y = \frac{bc-ad}{mc-na}$.

Problems.

1. A and B play ; and after A has won four shillings, he has left half as many shillings as B has. If B had won six shillings of A, he would have had three times as many as A would have had left. How many had each? Ans. A had 36, B 84.
2. What fraction is that to the numerator of which if 4 be added, the value is $\frac{1}{2}$; but if 7 be added to the denominator, its value is $\frac{1}{5}$? Ans. $\frac{5}{13}$.
3. Find two numbers, of which the greater shall be to the less as their sum is to 42, and as their difference is to 6. Ans. 32 and 24.
4. A person exchanged 12 bushels of wheat for 8 bushels of barley and £2 16*s*. At the same time he offered to sell a certain quantity of wheat for an equal quantity of barley and £3 15*s*. in money, or for £10 in money. Required the prices of the wheat and barley per bushel.
Ans. Wheat 8*s*. and barley 5*s*. per bushel.
5. 20 doz. of port wine and 30 doz. of sherry are sold for £120. At another time 30 doz. of port and 25 doz. of sherry are sold, at the same prices as before, for £140. What was the price per dozen of each wine?
Ans. Port 60*s*. and sherry 48*s*.

Simultaneous Equations with more than Two Unknown Quantities.

These are to be solved by the use of the methods employed to solve equations with two unknowns. The first thing to be done is to deduce from the given equations two equations containing two unknowns. Thus, to solve the equations :

I. $x+y+z=29$.
II. $x+2y+3z=62$.
III. $\frac{x}{2} + \frac{y}{3} + \frac{z}{4} = 10$.

From I. and II. eliminate x by subtraction. We get— $y+2z=3$.

From II. and III. eliminate x, after clearing III. of fractions, by multiplying I. by 6 and subtracting. We get—
$2y+3z=54$.
We have thus from the three given equations deduced two equations with only two unknowns :
$2y+3z=54$,
and $2y+2z=66$.
Solving these, we find that $z=12$. Then, since $2y+3z=54$,
$2y+36=54$
$2y=54-36=18$
$\therefore y=9$.
Substituting in the first equation these values of y and z—
$x+9+12=29$,
$\therefore x=29-21=8$.
The other methods which we used in solving equations with two unknowns are, of course, applicable to the solution of equations with more than two unknowns ; and the method of substitution especially often enables us to save much labour.

Equations with more than three unknowns are solved in a similar manner. It is always necessary that there be as many independent equations as there are unknown quantities.

Solve the equations :

1. $2x+3y+4z=16$
$3x+2y-5z=8$
$5x-6y+3z=6$
$x=3$. $y=2$. $z=1$.
2. $x+y+z=31$
$x+y-z=25$
$x-y-z=9$
$x=20$. $y=8$. $z=3$.
3. $x+y+z=29$
$x+2y+3z=62$
$\frac{x}{z} + \frac{y}{4} + \frac{z}{4} = 10$
$x=8$. $y=9$. $z=12$.
4. $\frac{4x+3y+z}{10} - \frac{2y+2z-x+1}{15} = 5 + \frac{x-z-5}{5}$
$\frac{9x+5y-2z}{12} - \frac{2x+y-3z}{4} = \frac{7y+z+3}{11} + \frac{1}{6}$
$\frac{5y+3z}{4} - \frac{2x+3y-z}{12} + 2z = y - 1 + \frac{3x+2y+7}{6}$
Ans. $x=9$; $y=7$; $z=3$.

END OF "ALGEBRA."

LIV.

The Time of Queen Anne.

Queen Anne, 1702—1714.

As William and Mary left no issue, the princess Anne, the second daughter of James II. and Anne Hyde, succeeded to the throne, as the next Protestant heir of the house of Stuart, by virtue of the Bill of Rights. Two great features characterise her reign : abroad, the fierce struggle embodied in the war of the Spanish succession, with the triumphs of Marlborough and

Eugene, ending with the treaty of Utrecht in 1713; at home the struggle between the Whig and the Tory party, maintained with equal obstinacy, and having for its subject no less important an issue than the maintenance of the Protestant succession, with the limits imposed on the power of the king, or the restoration of the Romanist branch of the Stuarts in the person of James, son of James II. and Mary of Modena, called by his partisans James III., King of England, Scotland, and Ireland, and by his opponents the Pretender. The first question was decided by the operations of armies in the field; the second by the efforts of rival ministers in the cabinet.

Queen Anne, "the good Queen Anne," as she has been sometimes called by a people strongly attached to hereditary monarchy, was but a weak-minded ruler, not destitute of good nature or without amiable qualities, but timid and vacillating, without gratitude for services rendered, a bad judge of individual character, and continually under the dominion of favourites; exceedingly selfish, moreover, and regardless of the principles to which she owed her throne, and which she promised at her accession to uphold.

Character of Anne.

ADMIRAL BENBOW.

The most violent among the old Tory party found matter for congratulation in the death of William III., and toasted "the little gentleman in black velvet,"—the mole that had raised the hillock which had caused William's horse, Sorrel, to throw his master, and thus occasioned the death of that wise and merciful king; but in general the nation approved and rejoiced when the queen, on her accession, declared her intention of prosecuting with vigour the war which had been forced upon the country by the insults and duplicity of the French king. The appointment of Marlborough to the post of general-in-chief of the allied army in Flanders was also considered as a pledge that the war would be prosecuted in earnest; while the capture of Venloo, Ruremond, and Liege by the famous commander within three months of his appointment, gave the best hopes of future success; and the thanks of parliament to the successful general, who was created a duke, with a pension of £5000, was a further proof of public feeling. The spirit of the navy, under the command of such sea-dogs as Rooke, Benbow, and Sir Cloudesley Shovel, worthy successors of the Drakes, Frobishers, Gilberts and Hawkinses of Elizabeth's day, was also good; and even the disastrous incident of August 1702 furnished a proof of dogged determination that gave good promise for the future. Benbow, in command of a squadron, having met the French West Indian fleet on the coast of Carthagena, signalled to his captains to bring their ships into action; but they basely deserted him, whereupon the brave old sailor fought, with his one ship, against ten of the enemy. When a shot had carried off one of his legs, he still remained on deck, in a cradle, and continued the action. On being condoled with on the loss of his leg, he declared he would have rather lost them both than that such dishonour should have been brought on his country. "But d'ye hear?" he continued, "if another shot should take me off, behave like brave men, and fight it out." He had four of his captains brought to a court-martial, and two of them were shot for cowardice. The taking of Gibraltar in 1704 was one of the most surprising feats during the war. The military triumphs of England during the contest have been already spoken of; they had not been gained without heavy cost. By the year 1713 the national debt had already increased to £38,000,000, and heavy taxes had been imposed year after year.

War of the Spanish succession.

Admiral Benbow.

The most important event in home politics in the reign of Anne was the union of England and Scotland in 1707. Until that year, though under one monarch, the two countries had had separate legislatures. There had been strong national antipathies between the two nations, and various jealousies leading to much injustice on either side. In trade, for example, the Scots were debarred from the advantages the English enjoyed in commerce with the colonies. It was jealousy that had caused the failure and utter ruin of the Darien expedition in the last reign. The Scots, moreover, were utterly opposed to the idea of the Hanoverian succession, and passed the Act of Security, to protect themselves from the necessity of acknowledging the Princess Sophia as their ruler. Such was the bitterness of feeling between the two countries that a war seemed imminent, but it was prevented by the judicious action of the commissioners appointed to negotiate the union, who conciliated Scotland by admitting forty-five members to represent that country in the house of commons and fifteen elective Scottish peers, by securing the National Church from alteration, and giving compensation for the losses incurred by the ill-starred Darien expedi-

Union of England and Scotland, 1707.

Naval commanders.

tion. The measure, greatly dreaded at first by the Scots, and described by some of them as "Scotland's treason," proved highly beneficial to both countries, especially to the north, by developing its resources.

The queen had been placed on the throne according to the principles of the Revolution of 1688, which event was a standing up against royal authority when abused, and consequently a denial of the doctrine of passive obedience and non-resistance. But as time went on there was a reaction in favour of high church doctrines, which advocated the inalienable supremacy of kings, and the necessity of strict conformity to the teachings of the Church of England. Hence, a bill was introduced into parliament to abolish the "occasional conformity" that had been

Toryism of Anne.

BENBOW FIGHTING THE FRENCH SHIPS.

allowed as a compromise. The queen herself, as she grew older, showed a leaning towards these principles. She had been the mother of seventeen children; but all had died,—the Duke of Gloucester, the last of them, in 1700; and she wished that her half-brother, the Pretender, should succeed her, rather than the Elector of Hanover. The Duchess of Marlborough, also, who had for years been all-powerful with the queen, was superseded in Anne's favour by a dependant of her own whom she had placed in the queen's service,—Abigail Hill, afterwards married to Mr. Masham. With the duchess, who was deprived of her offices about the court, and fell completely into disfavour, the Whig party lost power; and an injudicious act paved the way for the fall of the ministry.

On the 5th of November, 1709, a certain Dr. Sacheverell, rector of St. Saviour's, Southwark, preached a sermon at St. Paul's Cathedral (he had preached a similar one at Derby a few months before), in which he upheld the doctrines of passive obedience and non-resistance, and denounced the revolution of 1688 as subversive of Christianity. He was equally severe on all dissenters and low churchmen. The ministry thereupon impeached Sacheverell for publishing malicious, scandalous, and seditious libels. The Godolphin cabinet being already unpopular, this affair was taken up as a national matter, and the cry of "High Church and Sacheverell" became a rallying one among the people. Even the queen had her chair stopped by the mob in St. James's Street, who "hoped Her Majesty was for Dr. Sacheverell." The prosecution succeeded;

Dr. Sacheverell's trial.

Sacheverell was condemned to suspension from his office for three years, and to have his sermons burnt by the hangman. But he was consoled by the gift of a good living in Wales; and within a few months afterwards Godolphin had been ordered by the queen to break his staff as treasurer, and Harley, afterwards Earl of Oxford, and Henry St. John, afterwards created Viscount Bolingbroke, came into power, with a Tory majority to back them in parliament, and Mrs. Masham, as their humble servant, to influence the mind of the queen.

Harley and St. John.

After the treaty of Utrecht had been signed, a quarrel took place between Harley and Bolingbroke, each of whom had been intriguing for his own advantage with the Pretender, and accused the other of treachery. "We are indeed no admirers of the statesmen who

concluded the peace of Utrecht," says Lord Macaulay. "Harley, we believe, was a solemn trifler, St. John a brilliant knave. The great body of their followers consisted of the country clergy and the country gentry—two classes of men who were then inferior, in intelligence, to decent shopkeepers or farmers of our time."

Measures of the Whigs.

The Whigs, conscious of the intrigues that were going on, and of the influences brought to bear on the queen, whose health was every day declining, thought to secure the succession by urging the Elector of Hanover, who had been created Duke of Cambridge, to sue for a writ to take his seat in the House of Lords; but the queen was highly indignant at this, and forbade the coming of the Elector of Hanover. The old Electress Sophia died at the age of eighty-three years; and this simplified the position by making her son the Elector heir apparent. The queen was absolutely in a dying state, when she suddenly ordered Harley to give up his office of lord treasurer. A day or two afterwards, John, Duke of Argyle and Greenwich, a Scotch nobleman of great position and influence, accompanied by the Duke of Somerset—both attached to the Whig party—suddenly appeared uninvited in the council chamber at Kensington, ostensibly to inquire after the queen's health, but in reality to defeat, by their presence, the machinations of Bolingbroke and his party, and prevent the return of the exiled Stuart prince. The queen was induced to give the treasurer's white staff to the Duke of Shrewsbury; which proceeding meant a transfer of power to the Whigs. Every preparation was now made to have the Elector of Hanover proclaimed king, immediately on the queen's demise. Troops were brought to London, ships were prepared to intercept any attempted invasion, and these precautions had been completed with great judgment and expedition while the adherents of Prince James were still unprepared; and at this juncture the queen, who had been for some time in a lethargic state, quietly breathed her last in the palace at Kensington, on the 1st of August, 1714. She had reigned nearly thirteen years, and was not quite fifty years old.

Death of the queen.

GERMAN.

LIV.

German Version of the Exercise on p. 843, *for Correcting the Exercise.*

(N.B.—As we have now given the pronunciation, in so far as it can be represented in English, through a number of lessons, we shall in future omit it, only indicating it in the case of a word that presents any difficulties.)

Ein alter Philoſoph pflegte zu ſagen: „Ich habe oft bereut daß ich geſprochen habe, aber nie, daß ich geſchwiegen habe." Wilhelm der Schweigſame, Prinz von Oranien, der Befreier Hollands von der Tyrannei Philipp's des Zweiten von Spanien, gewann ſeinen ehrbaren Beinamen dadurch daß er oft ſchwieg, wo andere durch unüberlegte Worte in große Gefahr kamen. Die Hitze war ſo groß bei dem Brande von Moskau in 1812, daß das Blei von dem Dache des Palaſtes ſchmolz, und in Strömen nieder floß; und viele verloren das Leben bei dieſer fürchterlichen Feuersbrunſt. Alle Verſuche die Flammen zu löſchen waren vergebens. Die Franzöſiſchen Soldaten liefen zur Stadt hinaus, und die Cavallerie (Reiterei) ſprengte in Eile davon. Sie mußten in den Feldern liegen, bis der Brand nach einigen Tagen von ſelbſt erloſch. Letztes Jahr wurde die Erndte beinahe von dem Regen verdorben der Monate lang beinahe alle Tage herab goß. In manchen Gegenden ſchwemmte das Waſſer ſelbſt Bäume von hohem Wuchs fort, und erſäufte viele Kinder und Schaafe. Das Korn lag Wochen lang in den Feldern, und konnte nicht heimgetragen werden, weil es ſo naße war. Es verdarb in den Feldern, und die Hoffnung des Landmanns war für das Jahr verloren. In manchen Stellen ſchwollen die Flüſſe ſo (dergeſtalt) daß es unmöglich war, auf den gewöhnlichen Fähren die Leute über zu ſetzen. Viele erſchracken bei dem Anblick des rauſchenden Stromes, deſſen Zuſtand die Idee der Unſicherheit einflößte, und ſelbſt einen feſten Muth beugen könnte. Die Römer fällten die Bäume in den Wäldern Britanniens, und ſprengten die Schaaren der Eingeborenen auseinander, welche da Obdach gefunden hatten. Tapfer aber ohne Diſciplin (Zucht) konnten die Britten nicht gegen die Legionen der ſtreitbaren Fremdlinge ſtehen, welche endlich das ganze Land unter ihr Joch beugten. Es iſt gut die Folgen einer That zu erwägen; manche gute Sache iſt durch Uebereilung verdorben worden. „Eile mit Weile," ſagt das Sprichwort. Dieſer General verwirrte den ganzen Plan des Königs, durch ſeinen Mangel an Fähigkeit ihn zu verſtehen. Die Loire fließt durch das weſtliche Frankreich. Bei der Mündung dieſes Flußes liegt die große und wichtige Stadt Nantes. Als Guſtav Adolf in der Schlacht bei Lützen über das Feld ſprengte wurde er von einem Kaiſerlichen vom Pferde geſchoſſen. Er ſank zur Erde, und ſagte zu ſeinem Begleiter: „Ich habe genug, Bruder, rette dich." Gleich nachher ſtob die Kaiſerliche Reiterei über das Feld, und des König's Leiche wurde unter den Füßen der Pferde zertreten. Die heidniſchen Bewohner Nord-deutſchlands konnten nicht zum Chriſtenthum bekehrt werden, bis der Mönch Winfried, nachher Bonifacius genannt, mit der Art die

heiligen Eichen gefällt hatte, welche sie als die Sinnbilder ihres Glaubens ansahen, und als solche anbeteten. Die Königin Christina von Schweden, die einzige Tochter Gustav Adolfs, legte ihre Krone zu Gunsten ihres Vetters nieder; und man sagt daß sie nachher ins geheim diese That ihr ganzes Leben lang bereute. Der Wunsch einen mächtigen Alliirten zu gewinnen, wog mehr bei der Kaiserin Maria Theresia als der Gedanke an die alte Feindschaft zwischen Oestreich und Frankreich; sie wünschte die Macht Friedrich's des Großen zu verderben, und dachte dieses thun zu können weil es in ihrer Macht lag Ludwig den Fünfzehnten zu gewinnen. Über dem Kopfe des Damokles, eines Schmeichlers des Tyrannen Dionys, hing ein bloßes Schwert, und diese Gefahr war genug ihn in solchem Grade zu verwirren, daß er den Dionys bat ihn nicht länger regieren zu lassen. Das Schwert hat drei Monate lang an dem Nagel gehangen. In vielen Schlachten floß das Blut der tapfern Deutschen die Herrschaft über Italien für ihre Kaiser zu gewinnen. Aber die Macht der Deutschen in Italien sank mit dem Glücke des Hauses der Hohenstaufen. Friedrich der Erste, genannt Barbarossa oder der Rothbart, der mächtigste Kaiser aus jenem Hause, ertrank in dem Fluße Kalikadnus in Syrien. Es war in dem dritten Kreuzzuge. Die Pflanze sog Nahrung aus der Erde und wuchs hoch und stark. Von dem Winde gebogen, hielt sie sich noch, bis nach einem großen Sturme sie entwurzelt auf der Erde lag. Nachdem er von dem Giftbecher getrunken hatte, legte sich Socrates nieder, und redete munter mit seinen Freunden. „O daß du unschuldig sterben solltest, Socrates!" rief einer von ihnen. „Wie," antwortete der Weise, „wolltest du lieber, daß ich schuldig stürbe?" Jedermann sehe, daß er fest stehe, wo das Schicksal und die Pflicht ihn gestellt haben. Als er in Gefahr war, von seinen Feinden gefangen zu werden, sprang der Kaiser Otto in das Wasser, und schwamm auf einen Kahn zu, in welchem einige seiner Freunde saßen. Also rettete er sich aus des Feindes Hand.

ELECTRICITY AND MAGNETISM.

XXVII.

Voltaic Electricity.

Laws of circular currents.

Concerning our consideration of the action of currents upon each other, we will now notice the laws which govern the attraction and repulsion of circular currents.

If, as in fig. 97, we have two hoops of wire, A B, supported on a stand through which currents are allowed to pass in the direction shown by the arrows, it will be evident that if the hoops of wire be in the relative positions shown in the upper part of the diagram, the

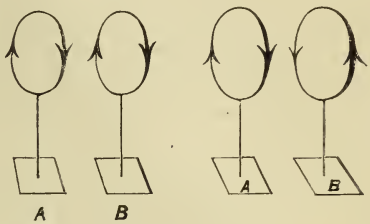


FIG. 97.

currents moving in the same direction will attract each other in all parts of their course. If, however, B were reversed with regard to A, the currents would then be going in opposite directions, and repulsion between them would necessarily occur.

Important cases of the relation between currents.

Thus far our consideration of the mutual action of currents upon each other has been unaccompanied with much difficulty; but there are one or two cases in which the relations of adjacent currents to each other will require more careful consideration. These cases, however, deserve all the care and attention we can bestow upon them, as they serve to illustrate the important fact that, knowing the action between any two rectilinear parts of a current, we can easily solve the problem as to the nature of the action which the whole current will have upon an adjacent current, whatever may be its form.

Action of an infinite current upon a free current.

We will first examine the action of an indefinite, or as it is sometimes termed an infinite, current, which is fixed and rectilinear, upon a portion of a second current free in space and perpendicular in direction to the first.

Let MN in fig. 98 represent the infinite rectilinear current travelling in the direction of the arrow, and let AB be a finite rectilinear current at right angles to MN and perfectly free in space. Let CD be a perpendicular common to AB and MN; it is obvious that this perpendicular will vanish if AB and MN meet each other. Consider first the case in which the current AB approaches MN (*upper figure*). The currents AB and MC approaching the apex of the angle, there will be *attraction* between them. This attraction we may represent by a force f, acting from a certain point m in AB towards a point p in MC. In the parts of the two currents AB and CN the currents are in the opposite direction to those on the other side of AB, that is to say, they are travelling *from* the summit of the angle, and consequently they will repel each other. As these currents are perfectly symmetrical with regard to those on the other side of the

point C, we may represent the repulsion between AB and CN by a force f' acting from m in AB towards a point f' in CN equal in distance from C to p in CM; f' will obviously be equal in amount to f. Now, according to the laws which govern the composition of forces —for which we must refer our readers to the articles on "Mechanics" which have appeared in these pages—we may substitute for the two equal forces f and f' a single resultant force F, bisecting the angle between them, and therefore parallel to MN. It follows therefore that this force F will draw AB in a direction parallel to itself and to MN, but in an opposite direction to the latter.

In the second case (shown in the *lower figure*), where AB is travelling away from MN, the result will, by parity of reasoning, be easily understood to be that AB will be drawn away in a direction parallel to itself and to MN, but in the same direction as that in which the infinite current is travelling. If A,B be below

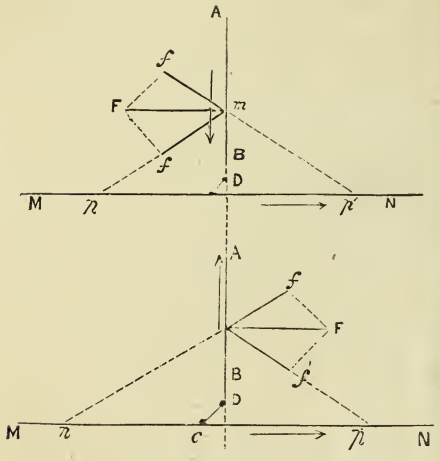


FIG. 98.

MN instead of above, these directions will obviously be in each case reversed.

Let us, however, suppose that instead of AB being perfectly free, it is only capable of moving on an axis parallel to itself, it will easily be understood that in the first case it would rotate on its axis in a direction towards M, and would remain in equilibrium when the plane of the axis and of the current have become parallel to MN, on the side from which the infinite current MN comes. In the second case equilibrium will result when the plane of the axis and of the current are parallel to MN on the side towards which the infinite current is directed.

Currents capable of moving on an axis.

It will also be seen that a system of two vertical currents rotating about a vertical axis above a horizontal current will be directed by this current in a plane parallel to itself, if one current be ascending and the other descending. If, however, both currents ascend or both descend, no motion will result, the action on one branch of the system counterbalancing that on the other.

We have next to turn our attention to the rotation of currents by currents. A reference to our diagram (fig. 99) will show how this is possible. If we have a circular wire in which a current is passing, and have perpendicular to this a horizontal current AB, it can easily be shown that AB is attracted by all the elements of the half circumference CPC', and is repelled by all the elements of the other half circumference CP'C'. Consequently the resultant will be a force F parallel to the chord PP,' drawn from the point D at right angles to the diameter CC', and tending to cause the circular current to pass up AB. Directly AB is, by the influence of this force, slightly displaced, it will of course be perpendicular to another diameter of the circle, but its relation to the circumference will remain undisturbed. AB will therefore tend to turn continuously round the axis OX so as to describe a cylinder. Should the rectilinear current travel from B to A instead of from A to B, rotation will still be set up, but it will be in the opposite direction.

Rotation of currents by currents.

A piece of apparatus by which the rotation

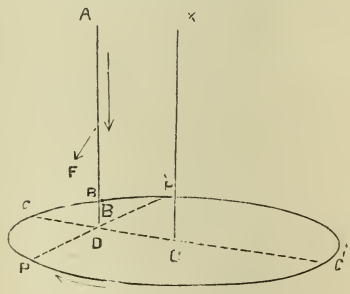


FIG. 99.

of a vertical current by a horizontal circular current may be experimentally verified is shown in fig. 100. It consists of a brass vessel round which about twenty turns of covered copper wire are coiled, and through this wire a current is made to pass. The centre of this brass vessel is occupied by a pillar, having on its summit a mercury cup, into which dips the pivot of a copper wire, the two extremities of which are bent down at right angles so as to form vertical branches. These branches are soldered to a very light copper ring, which is immersed in acidulated water contained in the brass vessel. The battery current enters by the binding-screw *a*, and passing round the coils of wire leaves by the binding-screw *b*, which is connected with the central pillar. It then ascends the pillar and passes through the bent wire to the copper ring, to which the ends of the wires are attached. It then passes through the acidulated water to the sides of the vessel, and returns to the battery by the binding-screw *a'*. When the current

Apparatus to illustrate rotation of currents.

passes, the bent wire and its attached ring tend to rotate in a direction contrary to that of the fixed current. The reason of this is easily seen, for the branch on the right is attracted by one portion of the fixed current, while the branch to the left is attracted in the opposite direction by the other portion of the fixed current; these two attractions will therefore coincide in setting up a continuous rotatory motion of the ring in the same direction. The horizontal part of the circuit in the bent wire would also be affected in a similar manner by the horizontal fixed current, but on account of the distance between these two their action is too small to require notice.

Not only, however, may currents be rotated by currents, but magnets may also have the same rotatory motion imparted to them. The discovery of this important fact is due to Faraday, and in fig. 100 we have represented the apparatus by which it may be shown. A is a large glass vessel almost filled with mercury, on the edge of which is fixed a metallic ring, B, which just touches the mercury. In the mercury is placed a small magnet, loaded with a platinum cylinder, *d*, by which it is maintained in a vertical position. The magnet projects a little above the mercury, and has on its upper end a small cup containing mercury. A copper wire is attached by one of its ends to the metallic ring, and by the other to the binding-screw *g*. Attached to the binding-screws *h* and *g* are wires leading to a commutator to which latter the battery wires are attached. As soon as the circuit is made, the current, entering we will suppose at *h*, traverses the pillar to which it is attached, passes to the magnet, thence into the mercury, and finally leaves by the binding-screw *g*. As long as the current passes, the magnet rotates with a rapidity depending upon the strength of the magnet and the intensity of the current. By reversing the direction of the current the direction of the rotation of the magnet is also reversed. The explanation of this interesting fact depends upon a knowledge of the Ampèrian theory of magnetism, to which we shall refer in our next article, and we will then return to a theoretical consideration of this phenomenon, which the reader will find worthy of close attention.

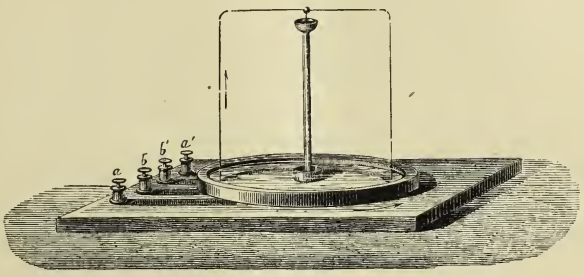


FIG. 100.

Rotation of magnets by currents.

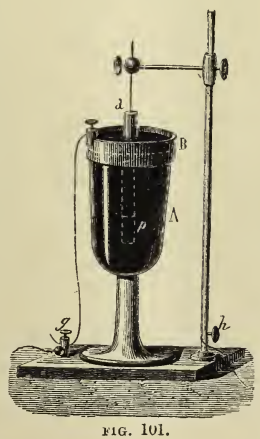


FIG. 101.

XI.

THE SECOND PERIOD OF ENGLISH LITERATURE (*continued*).

IN SIR JOHN FORTESCUE, Chief Justice of the Court of King's Bench under Henry VI., we have a prose writer of considerable merit. Sir John was a staunch Englishman, and had a great appreciation of the privileges and the good qualities of his countrymen, especially as compared with the Frenchmen, whom he considers as little better than slaves. Some part of his panegyric on his countrymen reads oddly, as coming from a grave judge; he asserts that robbery is a much more frequent offence in England than in France; and gives this as a proof of the superior courage of the English, speaking of the fact rather in a boastful tone. Besides several Latin tracts, Sir John Fortescue wrote in English a treatise entitled *The Difference between an Absolute and Limited Monarchy, as it more particularly regards the English Constitution.*

Work on the English Constitution.

A few sentences will give an idea of the author's style, and of the spelling of a learned man in the middle of the fourteenth century:—

"It hath ben often seen in England that iij or iv thefes hath sett upon vij or viij true men, and robyd them al. But it hath not ben seen in Fraunce, that vij or viij thefes have ben hardy to robbe iij or iv true men. Wherefor it is right seld that Frenchmen be hangyd for roberye, for that they have no hertys to do so terryble an acte. There be therefor mo men hangyd in England, in a yere, for roberye and manslaughter, than there be hangyd in Fraunce, for such cause of crime, in vij yers. There is no man hangyd in Scotland in vij yers together for robberye; and yet they be often tymes hangyd for larceny and stelying of goods in the absence of the owner therof: but their harts serve them not to take a manny's goods,

while he is present and will defend it; which maner of takying is called robberye. But the English man be of another corage: for if he be poer, and see another man having richesse, which may be taken from him by might, he wol not spare to do so."

The illustrious name of WILLIAM CAXTON has been constantly associated with the introduction into England of the art of printing—the art that was destined especially to spread through a world darkened by ignorance and superstition, the light of knowledge, religion, and truth. Indeed, the glory of Caxton the printer has in some measure hidden and eclipsed the fame of Caxton the author, though in the latter capacity the first of the English printers was a man of no mean merit. William Caxton was a mercer and citizen of London. For many years he resided in Flanders, as agent to the Mercers' Company; he was also employed in important and honourable business of state, both by Edward IV. and by that monarch's sister, Margaret Duchess of Burgundy. Caxton became acquainted with the art of printing in the Low Countries; and when between fifty and sixty years of age he printed at Cologne *The Recuyel of the Historyes of Troye*, translated by himself from the French. In 1472 he came to England, and under the patronage of the learned Lord Rivers, the Abbot of Westminster, Thomas Milling, and other men of influence, he established in the precincts of Westminster Abbey the first English printing press, whence issued, in 1474, *The Game and Playe of the Chess*—the first book known to have been printed in England. With indefatigable industry Caxton wrought at the art he had, to use his own words, "practised and learned at great charge and dispence." From his press there issued, before his death in 1492, more than sixty volumes, many being translated by himself. Other printers, probably from among Caxton's assistants, established themselves in London. Among them were Wynkyn de Worde, Thomas Hunt, Theodore Rood, John Lettowe, and William Machelina. Among the works of Caxton we find *The Noble History of King Arthur and of certain of his Knights, The very true History of the Valiant Knight Jason, The Life of Hercules, The Book of Æneydos, Treatises on Hawking and Hunting, Reynard the Fox*, etc. He had, as he himself says, to accommodate his diction and language in some measure to the limited capacity of his readers, and apologises for the fact that he found, after thirty years spent abroad, that "the language now used varieth far from that used and spoken when I was born." The following lament on the decline of chivalry, will show his style, which exhibited many French words. He exclaims:—

William Caxton (ab. 1412–1492).

The first printing press in England.

His contemporaries.

"O ye knyghtes of Englond; where is the custome and usage of noble chyvalry that was used in tho days? What do ye now but go to the baynes, and play at dyse? And some not well advysed use not honest and good rule, again all ordre of knygthode. Leve this, leve it, and rede the noble volumes of St. Graal, of Lancelot, of Galaad, of Trystram, of Perse Forest, of Percyval, of Gawayn, and many mo; ther shall ye see manhode, curtoyse, and gentylness.—I would demaunde a question, yf I shold not displease: How many knyghtes ben ther now in Englond, that have thuse and the exercise of a knyghte; that is to wite, that he knoweth his horse, and his horse him. I suppose, and a due serche sholde be made, there sholde be many founden that lacke; the more pyte is. I wold it pleasyd our soverayne lord that twyse or thryse a-yere, or as the lest ones, he wold do cry justis of pies (peace), to thende, that every knyghte shold have hors and harneys, and also the use and craft of a knyghte, and also to tornoye one agaynste one. or two agaynste two, and the best to have a prys, a diamond or jewel, such as shold please the prynce."

His style: French words.

Another specimen of Caxton's style is seen in the following extract from his translation of *Higden's Polychronicon*, printed in 1482:—

"And here I make an ende of this lytel werke as nygh as I can fynde after the form of the werk tofore made by Ranulph, monk of Chestre. And where as ther is fawte, I beseche them that shal rede it to correcte it. For yf I coude have founden moo storyes I wolde have sette in hit moo; but the substaunce that I can fynde and knowe I have shortly sette hem in this book, to thentente that such thynges as have ben done syth the deth or ende of the sayde boke of *Polychronycon* shold be had in remembrance and not put in oblyuyon ne forgetynge; prayenge all them that shall see this symple werke to pardone me of my symple and rude wrytynge. Ended the second day of Juyll, the xxii yere of the regne of Kynge Edward the IV. and of the Incarnacioun of oure Lord a thousand four honderd fourescore and tweyne."

His translation of Higden's Polychronicon.

Concerning the enormous importance of the art of printing, and of the method of manufacturing paper, the author of the *Amenities of Literature* justly observes: "The dearness of parchment and the slowness of the scribes made manuscript things only purchasable by princely munificence. It was the discovery of paper from rags, and the novel art of taking copies without penmen, which made books mere objects of commerce, and dispersed the treasures of the human mind free as air, and cheap as bread."

Important effects of printing.

Until this period, the task of chronicling the events of English history had been entirely in ecclesiastical hands. The monks were the chroniclers, and to record memorable events year by year was part of the recognised work of the convent, and every great monastery had its accredited historian. Thus we have the *Glastonbury*, the *Abingdon*, the *Peterborough*, the *St. Neot's Chronicle*, and a multitude of others; and the contents were sufficiently miscellaneous—miracles, strange accidents, and quaint comments by the scribe himself, probably embodying the general opinion of the

Old English Chronicles.

convent, being interspersed with here and there an anecdote. The famous *Polychronicon*, quoted above, ranks foremost among these monkish productions; and in itself it furnishes an illustration of the manner in which one monk in those days frequently poached on the literary manor of another. Ralph or Ranulphus Higden, of St. Werburg's Monastery, now the cathedral of Chester, took care to indicate, in the initial letter of every chapter, that Ralph, a monk of Chester, was the compiler. In the course of centuries, however, it was found out that Ralph had "conveyed" into the *Polychronicon* the "Polycratica Temporum" of brother Roger, another monk. In like manner the Italian chronicler Villani, writing in the fourteenth century, appropriated, without acknowledgment, the whole work of Mallspini, a writer of the thirteenth. In many cases these monks wrote rather from rumour than from personal knowledge, as is even acknowledged by one of the best of them, William of Malmesbury. In the fifteenth century, however, we note the first secular historians, in the chroniclers Fabian and Hall.

First English chronicers.

Robert Fabyan was a distinguished citizen of London, being alderman and sheriff. He wrote a *Concordance of Stories*, a compilation from various authorities, intended as a companion to his account of English affairs. There seems no attempt at arrangement or system in Fabyan's work. He mingles accredited facts with supernatural appearances of "flying dragons and fiery spirits in the air." He has been designated as "ter Catholicus"—three times a Catholic—a man of undoubting credulity, thoroughly convinced of the power and efficiency of the doings of saints and the working of miracles in England, while he says of a foreign miracle, "they must be fools who believe it." His chronicle is in seven unequal divisions, and extends to the end of Henry VII.'s reign. He had little idea of the relative value and importance of public events. "Fabyan," says Warton, "is equally attentive to the succession of the mayors of London and the monarchs of England. He seems to have thought the dinners at Guildhall and the pageantries of the City companies more interesting transactions than our victories in France and our struggles for public liberty at home." But Warton seems to be too severe on the worthy citizen, whose work is of great value to the antiquarian. Fabyan died in 1512; the first edition of his *Chronicle* appeared in 1516. In later editions, the *Chronicle* was "revised" by editors who studiously altered the expressions of the devout Catholic to suit the altered times. In the account of Becket's murder, the sentence "they martyred the blessed archbishop" is converted into "they slew the traitorous bishop." His Holiness the Pope becomes "the Bishop of Rome," and the legends of saints are ruthlessly swept away. It is interesting to compare Fabian's account of the rebellion of Jack Cade with the spirited portraiture of that event in Shakespeare's *Henry VI.;* both tell how the sturdy rebel "rode through divers streets of the city, and as he came by London stone, he strake it with his sword and said, Now is Mortimer Lord of this city."

Robert Fabyan (d. 1512).

His Chronicle revised.

Edward Hall, a more educated man than Fabian, writes in a better style than the worthy citizen, and has a better idea of the relative value of events. He was a learned lawyer and judge, and wrote an elaborate chronicle of England, extending to the time of Henry VIII. It is entitled *The Union of the Two Noble and Illustre Families of Lancastre and Yorke, with all the Actes done in both the Tymes of the Princes*, etc. Hall's *Chroniele* was the great source of information drawn upon by Shakespeare in his noble series of *Histories*.

Edward Hall (1499—1547: more erudite than Fabian.

X.

Shaping Machinery.

Shaping machinery may be conveniently divided into two classes—the first including those machines that press or mould the substance into the desired form, and the second those that cut away the extraneous parts.

In the machine used for bending steel pens to the required curve we have an illustration of the simplest apparatus of the first division, for the article is shaped by one stamp in the mould from which the bent pens are being delivered. A great number of articles are stamped in a similar way out of thin metal, generally brass, and may readily be distinguished from the more expensive and substantial cast articles by their lightness, and the nearly uniform thickness of the metal whatever the pattern may be.

But when the object to be pressed into shape is too large for such treatment, as in the manufacture of armour plates, iron rails, etc., then it is found more advantageous, and indeed necessary, to apply the pressure gradually from end to end by passing the metal between suitable rollers. In the "rolling" of armour plates the mass of metal is drawn in between two smooth-faced iron cylinders which are turned in opposite directions by steam power, and mounted in a strong frame so as to allow of the distance between the rollers being adjusted. The motion of the plate is exactly similar to that of the clothes in a domestic wringing machine or modern mangle. The manufacture of iron rails (for railways) is an operation very similar to the above, only that the rollers are hollowed out upon their surfaces so that the bar in passing between them may be pressed into the required shape, or partially so, the operation to be continued and completed by other pairs of rollers. The brass mouldings required for various machines are generally

shaped in a similar way ; three pairs of rollers suitable for this purpose are shown in fig. 30.

But by far the most important method of giving the required shape to any material, is that which consists in cutting away the parts that are not wanted. We need not refer to the simpler operations of this sort that may be seen in almost any workshop, inasmuch as the tools used can scarcely claim the title of machinery. Wood-carving, specimens of which may be seen in many cathedrals, churches, public halls, etc., is so nearly allied to sculpture that it is scarcely possible to imagine it the work of a machine. It is reason for thankfulness that a machine that should be able to produce such carvings as are sometimes in demand, would of necessity be so complicated that its expense would far exceed that of the skilled workman with his comparatively simple tools. But at the same time when many similar carvings are required, there is a point up to which the operations may with advantage be carried on by mechanical means, so that the artist is spared unnecessary labour. Carving machines, though simple in principle, are somewhat complicated in construction. The cutting is done by means of drills or "cutters," revolving at the rapid rate of from three to seven thousand revolutions per minute. The work is fixed to a table that can be easily moved in any direction horizontally by the attendant, and the cutter revolving over it, can be raised from the work or brought down on to it as occasion may require. Several pieces of wood may be shaped alike at the same time, by fixing them side by side on the table and having as many cutters so arranged that they shall work together. If it is wished to work from a pattern, the pattern must be fixed under a blunt guide, which takes the place of one of the cutters. By causing this guide to come into contact with every part of the surface of the pattern, each of the cutters reproduces the same form from the wood it operates upon.

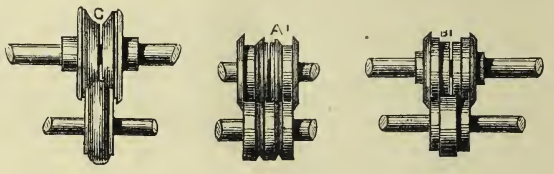


FIG. 30.

But of all shaping machines the *lathe* is by far the most important. Figure 31 shows a simple form of lathe that will conveniently serve for reference in descriptions of other kinds. The motive power here is obtained by the foot alternately pressing the treadle marked 4 4, and this motion is transferred by the connecting rod, 3, to the crank, 2, by which it imparts a circular motion to the shaft, and therefore to the fly-wheel that is fixed upon it. It will be observed that this motion is transferred by means of a cord to the pulley immediately over it, and that the relative sizes of the fly-wheel and the pulley serve to multiply the revolutions. The lathe proper consists of the "bed," A A, which is faced with steel on its upper surface and carefully levelled, so that the portions supported by it shall be true to one another. The "head-stock" is fixed to the bed, and supports the spindle, T, to the right-hand end of which the work is fixed by means of a suitable "chuck" which screws into it. Chucks are made of an almost endless variety of patterns according to the work that they are designed to secure, but the one important point is that they shall be true to their centre, for any inexactness in that respect must be quite fatal to good work. For the turning of small articles, such as boxes, the block of wood or the metal casting is secured to a chuck that takes the places of the one shown at M N, and the "rest," H, is brought near to it and fastened by means of a bolt, which passes through a slit in the bed of the lathe, and is secured below by a washer and nut not shown in the figure. The lathe is now started, and the tool taken in the workman's right hand, while with his left he grasps the rest, H, in such a manner that his thumb may firmly press the tool upon the top of the rest. The tool is then advanced to the rapidly revolving material, and so gradually reduces it to a perfectly circular form, and eventually to the desired pattern. If the work is long, as shown in the figure, then it is necessary to employ a front "centre" by means of the shifting head-stock, which may be secured at any part of the lathe-bed in the same manner as the rest.

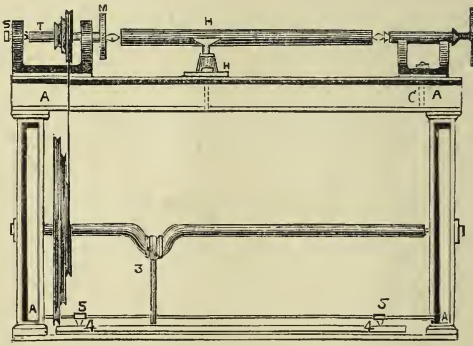
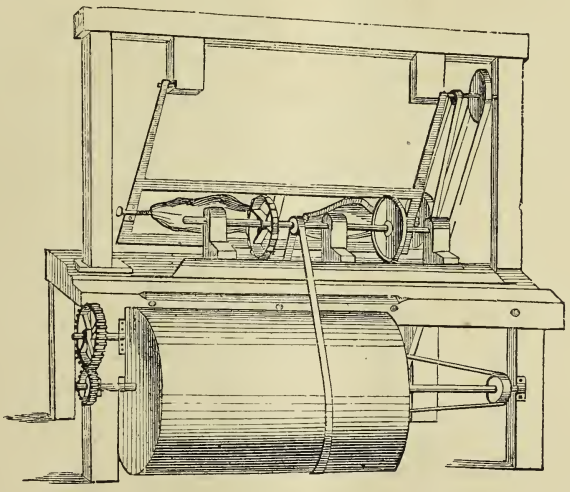


FIG. 31.

Lathes vary in many ways ; while the watchmaker uses one that is so small, it may almost be covered with one's hand, the engineer sometimes needs a lathe of such dimensions that a man appears a mere pigmy by its side. The larger sorts are invariably driven by steam power, and the whole of the operations are performed by the aid of suitable machinery. One of the most important developments of the lathe, as above described, consists in the "slide-rest" which replaces the simple one shown in the figure. In principle it is the same, but

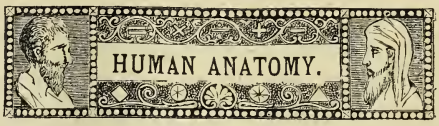
the turning tool is securely fastened to it, the important point being that the tool may be drawn along as the operation proceeds in a direction that is perfectly parallel with a line that joins the two centres of the lathe. Thus cylindrical objects may be produced with an exactness otherwise impossible.

But there is a large class of articles of a more or less irregular form, such as oar-blades, gun-stocks, boot-lasts, axe-handles, etc., for the turning of which it is necessary to make considerable departures from the general construction of the lathe as above set down. Figure 32 represents a machine that will serve to illustrate the principles by which such things are produced. The cylinder is caused to revolve by suitable means, and so by the band shown to impart a very rapid movement to the cutting wheel just over its centre. The wheel to the right is of exactly the same size as the cutting wheel, and fixed at a certain distance from it; and though it appears to be fixed upon the same shaft that carries the cutting wheel it is quite independent of it, the important point being that its axle shall be in the same line as that of the cutting wheel, and that the distance between the two wheels shall be unchangeable while the machine is working. This second wheel is the "guide wheel," and rests against the pattern, while the cutting wheel operates upon the block of wood. The pattern and the rough block revolve rapidly together upon the same axle, which is fixed in a swinging frame, so that the block is cut away by the cutting wheel, until the pattern touches the guide wheel, and the whole surface is thus gone over by moving the carriage that supports the two wheels along the bed of the lathe. By this means the pattern is exactly reproduced, for it is obvious that however the pattern moves with regard to the guide wheel, so must the shapeless block move with regard to the cutting wheel, or any obstacle must be cut away.



G. 32.

There are numberless other machines that might legitimately come under the heading of shaping machinery. But it has been the aim of the writer to illustrate general principles rather than to elaborate details, for these latter properly belong to larger treatises, where conciseness is not so much a desideratum as completeness.



XI.

The Skull as a Whole.

The Brain-case from the outside.

We may now consider the general characteristics of the entire skull. First, dealing with the brain-case, we see that its upper surface is a smooth continuous expanse, marked by certain sutures, or junctions and interlockings and overlappings of bones. Two of these are placed transversely, being the junction of the parietal bones respectively with the frontal and occipital bones. The first of these is called the *coronal** suture, from occupying the crown of the head; the third passes between these two in the middle line, at the meeting of the two parietals; it is called the *sagittal*† from its straight arrow-shape.

Sutures, coronal and sagittal, above.

Laterally the skull is considerably flattened, and by the prominence of the zygoma or yoke-bone there is marked out a considerable space, called the temporal space or pit. This rises rather high up on the side of the skull, and corresponds to the position of the temporal muscle. Behind and below this is the external ear-opening and the mastoid process.

The back of the head, or occiput, shows nothing notable but tranverse lines marking the attachment of muscles. Passing down from these we reach the base of the skull, where there are many objects of interest. There is the large hole, or *foramen magnum*, flanked by the occipital condyles. In front of it, and to the outer side of these, is the jugular foramen on each side, by which the jugular vein and the pneumogastric and other nerves come out of the brain-case.

Base of skull.

Further forward is the orifice of entrance for the carotid artery. On each side is the spike-like *styloid* process, and in front of it the pit for the articula-

Styloid process.

* Lat. *corona*, a crown.
† Lat. *sagitta*, an arrow.

tion of the lower jaw. In the middle line, again, we come upon the oval openings of the internal nostrils into the back of the throat. These are immediately behind the hard flat or concave surface of the palate, margined by the upper row of teeth.

Internal nostrils.

The Brain-case internally.

The skull encloses the large cranial cavity, which has an unbroken strong arch for its roof; but the base of the brain-case is very uneven, being broken up into three transverse regions. The middle of these pits descends deepest. The one in front is formed chiefly by the frontal bone, lies over the eyeballs, and supports the anterior lobes of the cerebrum or large brain. In its median part are the holes in the ethmoid bone for the olfactory nerves.

Interior view of base of skull.

Anterior pit.

The middle pit is made up chiefly by the sphenoid bone, and it supports the middle lobes of the cerebrum. At the junction of the lateral wings of the sphenoid with the middle portion the carotid artery and its accompanying vein, with several of the nerves to the eyeball, are placed. In the wings are holes by which two portions of the important trigeminal nerve pass out to supply the upper and lower jaws.

Middle pit.

Openings for nerves and arteries.

The posterior region of the brain rests on the occipital bone, and partly on the petrous part of the temporal. Resting on it most extensively is the cerebellum or little brain; while on the basal and median part of the bone there is the medulla or continuation of the spinal cord into the brain through the foramen magnum.

Posterior pit.

The Orbits.

The orbits, framed to contain the eyeballs, are very considerable and complicated cavities, formed by portions of many bones, of which the frontal, superior maxillary, ethmoid, and malar are the chief, and whose general shape is a four-sided pyramid with the base outwards. Most to be noted is the long fissure in the back and upper and outer angle, through which the bloodvessels and the nerves of the muscles and for general sensation enter from the brain-case. The special optic hole, for the optic nerve from the brain, is quite at the apex of the pyramid.

The great orbital fissure.

Besides these, there is another fissure between the bones in the base and outer wall of the orbit, by which there is a communication between the eyeball and the deep parts of the side of the face; and we must not forget the hole at the commencement of the lachrymal duct, at the inner and front angle of the orbit.

Opening of tear duct.

The orbits are so placed that they look straight forwards in the erect posture, and there is no hindrance to the eyes surveying any part of the front of the body and the limbs. This is a great contrast to the very lateral position of the eyes in most animals, which, combined with their downward look, prevents them from seeing much of their bodies.

Scope of view from eyes.

The carrying forward of the orbits, making them nearly parallel and close together, also gives the power of combining the two eyes in beholding any object. This, with the great flexibility of the head upon the neck, gives man an unrivalled field of vision, both over his own body and over surrounding objects.

The Nasal Cavities.

The structure of the parts related to the olfactory sense has many points of interest, partly depending on their being the usual channel of air in respiration, and their assisting and improving the voice. They open in front and below by the two nostrils, and they also open behind and below, by the internal nostrils, into the back of the throat. They communicate, by larger or smaller openings, with all the neighbouring bones which have air-sinuses in them—especially the frontal, maxillary, and sphenoid.

Openings, inner an outer.

The anterior part of the nose is formed of cartilages and skin. The nasal septum or bony partition is completed by a considerable septal cartilage; and the side-walls of the nose, below the nasal bones, contain two distinct cartilages, the upper and lower. The lower cartilages are peculiar in their arrangement, for each curves inwards over the front of the nose, and the two together combine with the proper septum; thus the tip of the nose is broadened. The lower and dilated region of the side of the nose is merely formed of thick skin.

asal cartilages and septum.

The *roof* of the nose is horizontal behind, but sloping in front; the floor is a regular and continuous gutter, which suddenly shoots behind into the throat. The arrangement of the spongy bones is such that the cavity between them is divided into three regions or galleries. The upper or true region of smelling is also the hindermost and smallest. The middle contains the openings into the various sinuses; the lower is the natural channel between the nostrils and the throat, and contains in its forepart the lower opening of the lachrymal canal.

Roof of nose.

Spongy bones.

The lower passage just referred to is perfectly smooth, and contains nothing to obstruct the free passage of air. The hinder opening can, however, be closed when the soft palate is thrown back against the back of the throat in swallowing.

Lower air-channel.

Air passes freely into the middle gallery of the nose, and the moist membrane stretched over the complicated spongy bones would soon be dried by the constant change of air in breathing, were there not some special adaptation. But the supply of blood-vessels and of secreting glands to the membrane is so copious, and their secretion so abundant, that we very rarely complain of the nose being dry;

Use of the lower nasal galleries.

the mouth and throat far more readily give us a sensation of dryness. The inspired air absorbing the warm fluid of these membranes becomes moist and warm, and better fitted to enter the very warm air-cells of the lungs.

Abundance of blood supply.

The abundant supply of blood to the nasal membrane, which has special communications by its arteries with those of the brain, renders the nose an important safety valve. When the brain is overcharged with blood, and liable to inflammation or congestion, serious consequences are frequently averted by a gush of blood from the nose, where there is comparatively little resistance to its escape from the vessels.

Safety valve action.

Bleeding from nose.

It is remarkable how completely the hairs placed at the entrance of the nostrils serve to prevent all but the smallest solid particles from gaining access to the respiratory system. It is a much more common event to *swallow* a small fly than to take one in through the nostrils.

Protection by hairs.

There is a backward slope in the floor of the nose, which is very instrumental in directing all its secretions into the throat, instead of outwards upon the face; but there are still more important agents than these. The cells on the surface of the membrane are nearly everywhere covered with very minute living hairlets or *cilia*, which are in constant vibrating motion during life, and so cause the fluid in which they are bathed to move in the direction of gravity.

Ciliary action.

It is manifest that the cavities of the nose and the air-sinuses in communication with them, forming so many resonant chambers, must have considerable influence in giving peculiar and personal characters to the tones of the voice. As the cavities are not precisely alike in any two persons, these differences will necessarily produce distinctions in that combining of the vibrations which constitutes the vocal tone.

ZOOLOGY.

XXXV.

The Bat Order.

The wings of bats and their mysterious nocturnal habits have always made them objects of speculation among mankind; and the blood-sucking character of some forms has given rise to many exaggerated and inaccurate reports about others. It was only in the seventeenth century that science clearly determined that bats belonged to the mammals and not to the birds, although it was known thousands of years ago that they brought forth their young alive and suckled them. The fact that bats possess a true power of flight outweighs in many minds the features which are less readily recognized, and gives them credit for being true birds. But they have complete series of teeth, a long tail of distinct vertebræ, hair and not feathers, and four highly developed limbs with five digits each.

Nocturnal habits.

Power of flight.

Flight is produced by the alternate upward and downward stroke of a thin membrane stretched from the side of the body to the four limbs, and especially connected with four very much elongated digits of the "hand." These wings are almost silent in action, and flexible enough to allow of ready turning. It must not be supposed, however, that the bat cannot "walk"; this is possible, in a shuffling way, when the wings are folded close against the sides. In the state of rest, however, it is well known that the bat hangs downwards, suspended by one or both feet. The body is light, but to support the muscles of flight the breastbone projects in the middle to form a keel like that of the bird; these muscles are large and powerful.

Elongated digits.

Breastbone.

The bats are most strikingly provided with organs of sense, aided by expansions of skin to which a most especial sensitiveness and power of touch is attached. There is even a capability of obtaining information by slight movements of the air in contact with these folds, which are well supplied with blood-vessels and nerves. Here a popular phrase is in error: to be "as blind as a bat" would be to have very capable eyes, if small. Of course they are not well adapted for daylight, and prefer twilight or night-darkness. The ear lobes and nose apertures are the subject of curious transformations in various members of the order, some being described as "margined," "hammer-headed," "horse-shoe," "trident," "diadem" and "lyre" bats.

Great sensitiveness.

Ear and nose lobes.

A number of species of bats feed entirely upon fruits; while others are animal-feeders, mostly devouring insects caught flying; but they include some whose principal diet is blood. Scarcely any part of the world lacks bats. Many of the fruit-bats range in the warmer oriental regions, with Africa and Madagascar. Very remarkable forms inhabit South America.

Food.

The Insectivorous Order.

Although many mammals feed upon insects, and some of the group to which the hedgehog belongs devour other food, animal and vegetable, yet the predominant diet of the animals in this order consists of insects, and largely of those which can be caught on and under the soil. They have usually short limbs, adapted for walking, and often for digging. Their grinding teeth are particularly tuberculated, so as to give them a high capability of crunching their prey. Their feet have usually five toes, and they walk on the sole. Like the bats, and unlike the carnivora, they possess collar-bones. They are mostly small, and the order includes, among the shrews, the smallest known mammals

Diet.

Teeth.

The Hedgehog is a well-known type of the order, noted for its power of rolling itself into a ball, and for carrying on its back hairs having the character of spines, an inch long. Thus it is most efficiently protected against attack, and is able to conquer even snakes by sudden bites and equally sudden coilings into a ball. It dwells in most varied situations, being often found in hedges, ditches, or forest-haunts. It goes abroad chiefly at night, and is one of the hibernating animals. Beetles constitute its chief diet, although slugs, snails and earthworms are not outside its taste or appetite. Foxes and owls prey on them successfully.

The hedgehog.

Power of coiling.

Moles are very subterranean creatures of voracious appetite, restless energy, and great constructive ability. Their burrows are marvels of skill, and their digging is effected by specially adapted, short, flattened, and powerful limbs. It appears probable that they are guided to their food by the sense of smell, which is very acute.

Mole burrows.

Order Edentata—Sloths and Ant-eaters.

This order includes some of the most singular animals now living, and still more remarkable extinct creatures. Almost all have only one kind of teeth—grinders, and these very simple in structure. They have long tongues, and their toes possess claws.

Simple teeth.

AUSTRALIAN ANT-EATER.

The Sloths are strange inhabitants of the trees of South America, which are specially adapted to hang suspended from tree branches. They are little qualified for the ordinary quadruped's marching order, for their claws are so curved inwards that walking must be performed resting upon them, and the ankle is permanently clubbed. The neck is long, having nine vertebræ instead of seven, but only six in another form of sloth. In general the number of toes is reduced to three on each foot, and in one genus it is further reduced to two on the fore-feet. They have strong jaws for chewing the leaves of the trees on which they live, and they are further adapted for their life by being of a colour which agrees extremely well with that of the trees and leaves. Their fore-limbs are much longer than the hinder.

Sloths.

Reduction of toes.

Where ants abound in countless myriads, making huge mounds for their dwellings, there is a variety of quadrupeds is found which derive their sustenance by the ant's destruction. The ant-eaters are provided with long tongues, and with large salivary glands capable of secreting considerable quantities of thick adhesive juice, by which ants are gathered wholesale into the mouth of their enemy. The head is usually long, and the feet are well adapted for digging and burrowing. South Africa not only has ant-eaters covered with hair and bristles, but also others provided with a peculiar investment of large overlapping scales, covering the whole body and the tail, which is as long as the body. So sufficient is their tongue to gain their prey, that they have absolutely no teeth. Some species occur in India, China, Sumatra and Java.

Ant-eaters.

Scaly ant eaters.

Toothless.

In South America there is a series of hairy ant-eaters which have their heads extremely long and slender, and the tail very bushy. They are toothless, and as perfectly adapted for preying on ants as their South African relatives; they can insert and withdraw their tongues covered with ants in less than a second.

Hairy ant-eaters.

Another great group of edentates, not so exclusively ant-eating as the last, is most efficiently protected by a bony crust developed in their skin, somewhat as in the crocodiles, but rivalling the latter in possessing separations between different portions of their armour, so that shields and bands are constituted, sometimes as few as three, in others reaching more than a dozen. These bands can be moved so that the creature can coil up into a ball somewhat like the hedgehog. They have simple teeth, and feed to some extent on vegetable food as well as insects, some also on carrion. They have large claws which are of use in burrowing. They inhabit South America.

Armadillos.

Gigantic fossil forms of Sloths (*mylodon*, *megatherium*) and Armadillos (*Glyptopon etc.*) were abundant in South America in recent geological periods.

FRENCH GRAMMAR.

XLVI.

The Verb (*continued*).—Theory.

1. The Various Classes of Verbs *continued*).—Impersonal Verbs. [Those impersonal verbs which refer to natural phenomena mostly have been under consideration: see *a*, p. 830.]

b. Impersonal verbs conjugated reflectively.

s'Agir de, to be at issue, to be at stake, to be the matter; conjugated like *finir* (p. 7): *il s'agit de nstre honneur*, our honour is at stake; *de quoi s'agissait-il?* what was the matter? *il ne s'agit pas que vous écriviez, il faut que vous alliez vous-même*, the point at issue is not your writing, you must go personally. [But what is the matter *with you* = *qu'avez-vous?* or *que vous manque-t-il?* NOT *de quoi s'agit-il avec vous?*]

s'Ensuivre, to follow as a consequence; an irregular verb, conjugated like *suivre*, given later on: *il s'ensuit de ce que vous venez de dire, que les hommes sont condamnés à l'erreur* (Bernardin de Saint-Pierre), from what you have just said, it follows that men are condemned to error; *il s'en est ensuivi un changement épouvantable* (Bossuet), there has resulted from it a frightful

change. [As a personal verb *s'ensuivre* is used in the 3rd pers. sing. and plur. only.]

S'ÉTABLIR, to gain ground, regular like *finir*: *il s'établissait peu à peu parmi eux, l'opinion que . . .* (Littré), the opinion was gradually gaining ground among them that . . .

SE FAIRE, to be, to happen; an irregular verb conjugated later on: *comment se fait-il que vous soyez toujours en retard?* how is it that you are always late? *il se fit un grand silence*, a great silence supervened; *et c'est ainsi qu'il se faisait que Charles II obéissait à la cour de Versailles*, and so it was happening that Charles II. was obeying the court of V.; *comme il se faisait tard*, as it was getting late.

S'EN FALLOIR, to be wanting, conjugated like *falloir*, given below: *il s'en faut de beaucoup que je sois content de vous*, I am far from being pleased with you. When this verb is accompanied by a negative, or a word suggesting a negative, either *ne . . . pas, ne . . . rien*, or *peu, presque*, etc., the verb of the subordinate clause is preceded by *ne*:—

il ne s'en faut pas de beaucoup, there is not much wanting; *peu s'en faut*, or *il s'en faut peu*, there is little wanting. } *que je ne vous renvoie*, for my dismissing you (= I feel much inclined to dismiss you).

SE PASSER, to occur, conjugated like *se fâcher*: *il se passe bien des choses*, there are many things occurring; *jamais peut-être dans un si court intervalle de temps il ne s'est passé de si grandes choses* (Barthélemy), never perhaps did such great things happen in so short a space of time.

SE POUVOIR, to be possible, conjugated like *pouvoir*, given later on: *il se peut que vous ayez raison*, it is possible that you may be right; *il ne se peut rien de plus beau*, nothing more beautiful can be imagined. [*Tout se qui se peut de plus magnifique*, the most magnificent thing imaginable; *ils étaient ignorants, tout ce qui se peut, dans la connaissance des Pères*, they were indescribably ignorant in the knowledge of the Fathers.]

SE RENCONTRER, to happen, to coincide with, conjugated like *se fâcher*: *il se rencontre ici une aventure merveilleuse*, there happens here a singular coincidence, or, by a wonderful coincidence in this case; *il s'est rencontré des hommes de ce caractère*, men of that stamp have been met with.

It will be useful to observe here how in most of the foregoing examples the impersonal verb could be turned into a personal one by the disappearance of *it*, the apparent subject. [*S'agir de* must be excepted, unless it be replaced by another phrase: *il s'agit de notre honneur = notre honneur est en cause.*]

Taking each section in turn, we find: *Que les hommes sont condamnés à l'erreur s'ensuit de ce que vous venez de dire*, that men are condemned to error follows from what you just said; *l'opinion s'établissait parmi eux*, the opinion was gaining ground among them; *un grand silence se fit*, a great silence supervened; *peu s'en faut*, little is wanting; *bien des choses se passent*, many things are occurring; *la chose peut se faire que vous ayez raison*, or *vous pouvez avoir raison*, you may be right, etc.

c. Impersonal verbs used with an indirect object of a person:—

ÉCHAPPER, to do inadvertently, conjugated with *avoir* or *être*: *il lui échappera quelque sottise* (Littré), he will inadvertently do or say something foolish; *jamais il ne m'a échappé une seule parole qui pût découvrir le moindre secret* (Fénelon), never has there escaped me a word that might disclose the least secret; *il m'était échappé d'en faire confidence* (Corneille), I had inadvertently confided it.

PLAIRE, to please, to choose: *il me plaît d'agir ainsi*, I choose to act so; *s'il vous plaît*, if you please; *plaît-il?* what is your desire? [The last phrase, much used in answer to the call of one's name, offers the ellipsis of the objects, as it stands for *que vous plaît-il?* If you please, being translated literally, gives *si vous plaisez*, which means, if you are pleasing, agreeable.]

BISCACHA. DOLICHOTIS. RHYNCOTUS. ARMADILLO.

PRENDRE, to be seized by: *il lui prend un frisson*, he is seized by a shiver; *il prit à cet homme un dégoût de la vie*, that man was seized by a disgust for life; *il lui a pris en gré d'apprendre l'escrime*, the fancy has taken him to learn fencing.

EN * PRENDRE, to be lucky or unlucky, to have consequences, to get on, to come off well or badly: *il en prit aux uns comme aux autres* (La Fontaine), they got on just alike, they shared a like fate. [Both *prendre* and *en prendre* admit of the ellipsis of the apparent subject *il*: *Bien lui prend de n'être pas de verre* (Molière), it is lucky for him he was not made of glass; *mal vous en prendra si vous n'écoutez pas mes avis*, you will get on badly (you will have cause for regret) if you do not follow my counsels.]

TARDER, to long to, followed by *de* with the infinitive, or by *que* with the subjunctive, and conjugated with *avoir*: *il me tarde de revoir mes enfants*, I long to see my children again; *il me tardait qu'on me permît de rentrer*, I was longing to be permitted to return home. [In older French the subjunctive of the subordinate clause was accompanied by *ne* expletive: *il me tarde bien que je n'aie des habits raisonnables* (Molière), I long to have decent clothes.]

d. Impersonal verbs which may appear with or without an indirect object of a person. [We single out *sembler* and *falloir*; the rest present no special difficulty.]

* This *en* is an expletive, a *filler-up*.

1. With the exception of *to do* and *to get*, there is hardly, from the foreigner's point of view, a verb more ubiquitous in English speech than *to think*. Whether this points to a philosophic habit in the people, or to a paucity of synonyms in the vocabulary, is irrelevant. This verb is rendered into French rather less by *penser* than by *croire*, *songer*, *juger*, and *sembler*. The last would be most appropriate in these phrases :—

I think so = *il me semble que oui ;*
We do not think so = *il nous semble que non ;*
What think you of it? = *que vous en semble?*

2. Conjugation of FALLOIR, to be necessary.

INFINITIVE.

Present, falloir, *to be necessary*
Past, avoir fallu, *to have been necessary.*

PARTICIPLE.

Present, none [*necessary*
Past, fallu, *been necessary ;* ayant fallu, *having been*

INDICATIVE.

Present, il faut, *it is necessary*
Imperfect, il fallait, *it was necessary*
Perfect Definite, il fallut, *it was necessary*
Future Absolute, il faudra, *it will be necessary*
Perfect Indefinite, il a fallu, *it has been necessary*
Pluperfect, il avait fallu, *it had been necessary*
Perfect Anterior, il eut fallu, *it had been necessary*
Future Anterior, il aura fallu, *it will have been necessary*

CONDITIONAL.

Present or Future, il faudrait, *it would be necessary*
Past, il aurait (*or* il eût) fallu, *it would have been necessary*

SUBJUNCTIVE.

Present, qu'il faille, *that it may be necessary*
Imperfect, qu'il fallût, *that it might be necessary*
Perfect, qu'il ait fallu, *that it may have been necessary*
Pluperfect, qu'il eût fallu, *that it might have been necessary*

To be necessary, selected here as a rendering of *falloir* for convenience' sake, would prove a clumsy translation in the majority of cases. When *falloir* is followed by an infinitive purely and simply, or by an infinitive accompanied by its indirect object of the person, or by a subjunctive, it is best to construe it with *must*, *to have to*, *to be obliged to*, *to be incumbent on*, and the person inferred or expressed as a nominative. When *falloir* is followed by a noun, *to want*, *to require*, *to have need of*, will prove correct readings. We shall take these cases in order :—

(i.) How to render *falloir* followed by an infinitive only.—In some proverb, truism, or general proposition, when nothing in the text or context indicates that the truth is applicable to any one in particular, it is best to use *to be necessary* and *one must* :—

Il faut voir le monde pour se former, *it is necessary to see the world in order to educate oneself*, or *one must see, etc.*

Elle parle plus qu'il ne faut, *she speaks more than it is necessary* (*she speaks more than she should*, equally correct, might apply to a special circumstance).

Il faut, autant qu'on peut, obliger tout le monde (La Fontaine), *one must, as much as possible, oblige everybody.*

When the general sense or context permits the inference that what is said is applicable to a particular individual, *must*, *to have to*, *to be obliged*, etc., are preferred :—

Longtemps il hésita, mais lorsque je lui appris la nouvelle, il fallut se soumettre, *for a long time he hesitated, but when I told him the news he was obliged to submit.*

Mes enfants, il faudra courir pour arriver à temps à l'école, *children, you will have to run in order to reach school in time.*

Mon garçon, me dit-il, il va falloir partir, *my boy, said he to me, you will have to go* (*it is going to be necessary for you to depart*).

(ii.) How to render *falloir* followed by an infinitive preceded by its indirect object of the person.—This construction leaves no doubt as to the subject of *must*, *to have to*, etc. It is the person whose indirect objective pronoun precedes the infinitive :—

Il me fallut essuyer les mauvais traitements de mon maître, *I had to submit to my master's ill-usage.*

Il nous faut gagner du temps, *we must, we have to, gain time* (also *it is necessary for us to*).

(iii.) How to translate *falloir* followed by *que* and the subjunctive.—This is done in the same manner as in (ii.), because the nominative to *must*, etc., is suggested by the nominative of the verb in the subordinate clause—that is, the subject of the subjunctive :—

Il faut que j'aille, *I must go ;*
il fallait que tu allasses, *you had to go ;* [*there ;*
il fallut qu'il s'y rendît, *he was obliged to betake himself*
il faudra que nous le fassions, *we shall have to do it.*

Observe how each of these phrases might be constructed with the infinitive in French :—

Il me faut aller, *I must go ;*
il te fallait aller, *you had to go ;*
il lui fallut s'y rendre, *he was obliged to repair there ;*
il nous le faudra faire, *we shall have to do it.*

The construction with the infinitive presents, however, the danger of rendering the sense dubious ; for instance, *il nous le faudra faire* bears the double meaning "we shall have to do it," and "you will please do it to us," or "you will have to do it to us." The use of the subjunctive removes all doubt.

(iv.) How to translate *falloir* followed by a noun.—In this position it indicates a lack, or a simple requirement, and is rendered by *to lack*, *to want*, *to require*, *to demand*, *to charge for*, etc.

Votre toilette n'est pas complète, il vous faut un beau châle, *your dress is not complete, you are lacking a beautiful shawl.*

Il nous faut un billet, *we want a ticket ;* il nous faut encore un billet, *we are one ticket short*, or *we want another ticket.*

Que vous faut-il pour ce cheval?—il m'en faut cent guinées, *what do you charge* (*what do you want*) *for this horse?—I want a hundred guineas for it.*

(v.) Remarks on some idiomatic uses of *falloir*.

In a familiar, unconstrained style, this verb suffers sometimes the ellipsis of *il* : *allons, mon fils, marchons : fallut se rendre, fallut partir* (Voltaire), come, my son, let us be off : I had to submit, I had to go ; *s'il faut du Faust, pas trop n'en faut* (from a comic paper), if we must have Faust (Goethe's? Gounod's? Berlioz's), avoid having too much of him.

Faut-il, fallait-il, express a regret : *Faut-il avoir du guignon!* what a pity to have such ill-luck! *Fallait-il qu'il entreprît ce voyage!* what a pity he undertook that journey!

A threat implied : *il m'écrit qu'il me coupera les vivres, c'est ce qu'il faudra voir*, he writes to me that he will stop my allowance ; I should like to see him do it.

With the force of an adverbial phrase : *on les battit, il faut voir!* they were beaten, oh, so thoroughly ; *pour aimer comme il faut, il faut savoir se dévouer*, to love properly one must be able to devote oneself.

C'est un homme comme il faut = he is a well-bred man, a gentleman ; *c'est l'homme qu'il faut* = he is the right man in the right place ; *c'est un homme comme il en faut* = he is a man such as are required.

L.

Rome (*continued*).

Domitian having left no heir, the senate elected one of themselves, M. Cocceius Nerva, as emperor. Nerva's four successors were also chosen by the senate, and these five were the best rulers Rome ever had, and their times were the happiest for the empire. To keep the Prætorian guards in check, Nerva adopted as his heir and partner Trajanus, the best of all his generals, who was at that time in command of the Rhine legions. Then, having reigned but sixteen months, he died, and Trajanus, or Trajan as he is generally called, with the consent of the senate became sole ruler. He was a Spaniard, and the first emperor who was not an Italian. His popularity with all classes was unbounded. The soldiers were devoted to him because he was a good general; the people loved him because he was gracious and kindly, as well as just; and the senate, to mark their high opinion of him, gave him the title of "Optimus," the Best—a title which was given to no other emperor. He undertook two great military expeditions—against the Dacians and against the Parthians. Dacia, including the modern countries of Hungary and Roumania, was completely conquered, and to this day the province of *Roumania* testifies by its language as well as its name the thoroughness of its settlement. His invasion of the East was even more brilliant, and he led his legions right down to the Persian Gulf; but these conquests were not permanent, and on his return he died of a wound, in A.D. 117. In the interval between his two expeditions, he did much to beautify Rome, and built many useful buildings all through Italy. The forum and column of Trajan are still to be seen in Rome, after being buried under accumulations of *débris* for centuries; and the bronze reliefs upon the column depict his exploits against the Dacians.

Nerva, A.D. 96–98.

Trajan, A.D. 98–117.

Conquest of Dacia, A.D. 101.

Expedition against the Parthians, A.D. 114.

Improvements in Rome.

The Christians suffered a good deal in this reign, being suspected unjustly of revolutionary designs against the government and society as then constituted.

The Christians.

Trajan adopted on his deathbed his nephew Hadrian, who was a Spaniard also. He abandoned the East, thinking that the empire was quite large enough without it, and devoted himself to travelling through his dominions and looking after things with his own eyes. He visited even Britain, and to keep off the troublesome northern tribes he built the great wall between the Tyne and the Solway, which still exists, and is known by his name. He was succeeded in A.D. 138 by Antoninus, surnamed Pius, or the filial, on account of his affection for his adoptive father Hadrian. He was a philosopher and a humane ruler, devoting himself unremittingly to the welfare of his people and to the encouragement of all that was noble and good in human nature. His reign of twenty-one years was peaceful and happy, and uneventful. He adopted Marcus Aurelius, and gave him a share of the government during his life. Marcus was a philosopher, even more learned and studious than his father, but he fell on evil days. Wars and revolts on all sides kept him occupied in a manner by no means to his taste. But he saw that it was his duty to look after the safety above all things of his empire, and he resigned himself, like a Stoic, as he was. The Germans on the north made incessant attacks upon the Roman frontier, being driven on by the Russians, who were crowding them westwards. Marcus Aurelius died in the year A.D. 180 at Vienna, while fighting against the barbarian invaders. Though considered by historians to have been one of the best men who ever lived, his memory has one deep stain upon it,—the frequent and wholesale persecutions of the Christians.

Antoninus Pius, A.D. 138–161.

Marcus Aurelius, A.D. 161–180.

Frontier troubles.

He was succeeded by his son Commodus, a coarse and cruel man, who was soon murdered by his own servants. Pertinax, a senator, was chosen to succeed him; but the Prætorian guards took offence at his sternness, and killed him in three months. For nearly a hundred years after this the emperors were chosen by the soldiers without any regard to the senate. When a vacancy occurred in the throne, the legions which happened to be most powerful at the moment generally proclaimed their own general emperor. Very often the new emperor's title was disputed by the general of another army; and even if all acquiesced for the time, the emperor was sure to make enemies of his soldiers the moment he attempted to check their fearful lawlessness, and then he was assassinated, and some one else put in his place, to meet the same fate before long. The soldiers carried everything their own way, and the people had to submit to exorbitant taxation and tyranny of every kind. Very few of these military emperors are worth remembering, and we shall only mention a few.

Commodus, A.D. 180–192.

Pertinax, A.D. 192.

Emperors chosen by the soldiers.

Septimus Severus was an able general and beneficent ruler. He visited Britain, strengthened the wall which Hadrian had built from the Tyne to the Solway, and died at York (211). Caracalla was a hateful tyrant; but he completed the extension of the privileges of citizenship to all the provinces. Alexander Severus, A.D. 222—235, deserves to

Septimus Severus, A.D. 194–211.

Caracalla, A.D. 211–217.

be remembered for his noble efforts to administer justice to all his subjects—efforts which cost him his life.

We have now arrived at the time when the Roman empire began to be seriously harassed and weakened by the attacks of the barbarians on her extensive frontiers. Hitherto Rome had been the aggressor, and had kept her neighbours in wholesome fear; but of late their respect for her had sadly fallen off, and in many places they had taken advantage of the internal fighting and confusion to make destructive raids inside the Roman boundaries. These raids gradually became more formidable, until the defeat of the Roman legions in pitched battles became a not unfrequent event. The tide of Roman supremacy was fairly on the ebb. The most formidable of these border

Encroachments of the barbarians.

restored for a time the failing power of the empire. He, in fact, divided the empire among four rulers. There were two *Augusti*, himself and Maximianus, and two *Cæsars*, whose authority was somewhat less than that of the *Augusti*. These four did good work so long as they worked together, and beat back the barbarians on all sides. Moreover, the soldiers were kept in check by the knowledge that the death of one of the four would be avenged by the other three. After twenty-one years of hard work, Diocletian voluntarily abdicated, and lived for the remaining nine years of his life in retirement in Dalmatia. His abdication was followed by civil wars among the other rulers for nearly twenty years, when Constantinus, known as Constantine the Great,

Diocletian, A.D. 284–305.

Changes in the government.

His abdication.

ROMAN REMAINS—NORTH WALL OF RICHBOROUGH.

enemies were the Franks, who afterwards gave their name to *France*; and the Goths, or North Germans. These kept up continual attacks along the Rhine and Danube, and the Goths subsequently spread almost all round the empire, and eventually established themselves permanently inside it. The first actual loss of territory was the abandonment of Dacia to the Goths in 270.

Franks and Goths.

Besides these Germanic invaders, the Persians in the far east had begun to give great trouble; and one unfortunate emperor, Valerian, fell into their hands, and had to taste the bitterness of the cup of captivity, which Roman generals had for centuries obliged their defeated rivals to drain.

Persians.

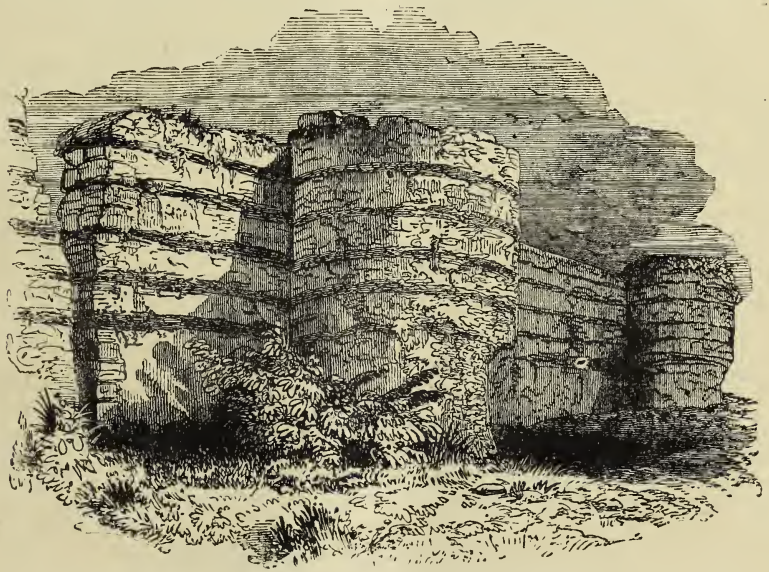
Diocletian, who seized the throne in 284, made important changes in the government, and succeeded in making himself sole emperor. His reign is remarkable for two highly important events; namely, (1) the establishment of the Christian religion as the religion of the empire, and (2) the founding of Constantinople, and the transfer of the seat of government to it.

Constantine the Great, A.D. 323–337.

Christianity, in spite of fierce outbursts of persecution, had gone on gradually growing and spreading. The emperors were all hostile to it, because it withdrew its followers from the festivals and customs of the old Roman religions. It was the only one of the numerous new religions constantly being admitted by the Roman priests which claimed exclusive obedience. The Romans had always extended the widest toleration to all gods and their worshippers; but Christianity would make no compromise

Christianity.

with other beliefs, and Christians refused to take any part in the worship of any gods but their own, and even vehemently preached against all such worship. For this conduct, as well as for their holding aloof from the amusements of the people, they were highly unpopular, so that to persecute them was an easy way for the emperors to gain the favour of the mob. This the emperors were not loth to do, for they thought the Christians were teaching the people to disobey the laws and to look to a higher authority than the emperor himself. And it was often the good emperors who were the most determined to stamp out what they thought was an element of lawlessness among their people. Thus the wise Trajan and Marcus Aurelius were perhaps worse persecutors than the infamous Nero; and Diocletian is said to have been the worst of all. For ten years a rigorous system of annihilation was carried on; but the time had passed, if there ever had been a time, when the new religion could be stamped out. The old religions had lost their hold of the people; their misery led them to long for spiritual consolation such as only Christianity offered them; and the noble constancy of the martyrs filled them with a wondering admiration for the spirit which could inspire such devotion. At last Constantine saw that the emperors could never conquer the Christians, and wisely determined to make friends with them, and thus get on his side the strongest moral power in the empire. In the year 325 was seen the strange sight of the emperor, surrounded by his guards and great officials, presiding over a council of Christian bishops—the celebrated council of Nicæa. It was a recognition of the new faith of tremendous moment to all after ages.



ROMAN MILITARY BUILDING—WALLS AT BURGH-UPON-SANDS.

LATIN.

LIV.

Syntax of Adverbs.

The Latin adverb qualifies verbs, adjectives, and other adverbs, just as the English adverb; and in this respect the adverb is to the word it qualifies what the adjective is to the substantive. Thus we have in *tantus amor*, so great love, the adjective *tantus* qualifying *amor*, the substantive; and in *adeo amare*, to love so much, *adeo amans*, loving so much, and *adeo amanter*, so lovingly, the adverb *adeo* qualifying the participle *amans*, the verb *amare*, and the adverb *amanter*.

1. In the following cases an adverb is constructed with a substantive to qualify it.

(1) In the case of the numeral adverbs *iterum*, *tertiùm*, *quartùm*, as marking the number of times an office has been held—as in *Consul iterum*, *tertium*, *quartum*, consul for the second, third, fourth time.

(2) Some adverbs of place are joined to substantives as if adjectives to qualify, as *circà*, *extrinsecus*, *superne*, *infrà*—as *Multæ circà civitates*, many surrounding states.

(3) The adverb is sometimes used as qualifying a noun when the noun is *participial in sense*—as in *populus latè rex*, a people widely ruling (as if *regens*).

2. The adverb *partim* (originally the accusative of *pars*) is often used as the subject of a sentence, especially where *partim* = *alii* or

alia (of things)—as in *Eorum autem beneficiorum partim ejusmodi sunt ut ad universos cives pertineant*, PARTIM *singulos ut attingant*, but of those acts of beneficence, some are of a character to extend to one's fellow-countrymen generally, others to affect individuals only.

3. Adverbs are compared together after the same method as adjectives, especially those from which they are derived—as in *Vehementiùs quam cauti*, with more vehemence than caution.

4. Some adverbs derived from adjectives governing a dative case themselves govern a dative case—as in *Congruenter naturæ vivere*, to live agreeably to nature.

5. The comparative of adverbs sometimes governs the ablative case in the same manner as that of adjectives—as in *Quid prius dicam solitis parentis laudibus?* what shall I declare in preference to the wonted praises of the Father? (of the gods).

6. The usages of the adverbs *ita* and *sic* must be noticed carefully.

(1) *Sic* is derived from *hic*, and means strictly *in this way*, and so is used always in *descriptive* passages or passages of *illustration* —as in *Sic itur ad astra*, it is in this way people go (it is gone) to the stars.

(2) *Ita* is derived from *is*, *that*, and means strictly *in that way*, referring to something expressed or implied in the context—as in *Ut quisque est vir optimus ita difficilime esse alios improbos suspicetur*, just in proportion to a man's excellence, so (in that proportion) with the greatest difficulty he suspects others to be evil (or unprovable).

(3) *Ita* after *non* (not) and *haud* (certainly not) means *extremely* or *very*, and has the force of *admŏdùm*—as in *Nec ita multo post*, and not very long time afterwards.

(4) *Ita* in adjuration acquires something of the force of *adeo*—as in *Ita me dii ament, honestus est*, so may the gods love me, (as) he is an honourable man.

(5) The adverb *satis* (sufficiently) sometimes means, by a sort of euphemism, *considerably*—as *Satis cum periculo*, with considerable peril.

(6) The adverbs *minus*, *parum*, *male* (in a less degree, in a small degree, and badly) are often used with a *negative* force, when they are equivalent to a softened *non*: but *minus* is equal to a decided *non* after *quo* and *sin*—as *Quominus* and *sin minus*, while *parum* is never quite a decided negative, but always means less *than might generally be expected*—as in *Parum succedit quod ago*, what I do succeeds less than might be expected; but *L. Cotta in senatum minus venit*, L. Cotta scarcely if ever comes into the senate at all.

You will now see that we are beginning to be carried into the distinctions of synonymous words, and accordingly you will find the distinction of synonymous words more fully and carefully dwelt upon in this and the following vocabularies, as this forms a most essential and interesting portion of Latin scholarship, without which you cannot possibly understand and appreciate the subtle discrimination and wonderful word-painting used by the most classical and perfect models of Latin style.

Vocabulary of Latin Synonymous Words.

vinculum (poetry—vinclum), any binding
catenæ, chains
compedes, pedicæ, fetters (for the feet, *pes*)
manicæ, manacles (for the hands, *manus*)

vindicta, just vengeance
ultio, angry revenge
talio, retaliation

pœna, punishment imposed as a *reparation*, penalty
multa or mulcta, a *pecuniary* punishment, a fine
castigatio, chastisement for correction
supplicium, corporal punishment

vinum, wine generally
temetum (poetical and ancient form)
merum (supply vinum), wine and wine *only* (*i.e.* unmixed with water)

virgo, an unmarried woman
puella, a young woman (married or unmarried)
virago, a masculine woman, an Amazon

vita, life in public
victus, life in private, or the means of living (*victu*)

culpa, fault
vitium, any flaw or vice
menda, a *bodily* blemish
mendum, an error
macula, a stain which disfigures
scelus, crime (against man)
nefas, sin (against God)

volucres, winged creatures
aves, any birds
alites, large birds (augury from flight)
oscines (augury from cry), birds of omen

barathrum, an abyss
vortex, a whirlpool
gurges, a waterfall

vulnus, a wound from a weapon
plaga, a wound from a dangerous instrument
ulcus, a festering sore (or *ulcer*)
cicatrix, a scar left behind
vulneratus, wounded generally
saucius, disabled (or wounded to the death)

Observe also—

consulo aliquem = I consult some one
consulo alicui = I consult *some one's interest* (dat. of advantage)
consulo in aliquem, I proceed against some one (in law)

animadverto aliquid, I turn my mind (or attention) to something—*i.e.* observe it
animadverto in aliquem = I turn my attention to some one—*i.e.* I punish some one

manet aliquem = it awaits me
manet alicui = it is reserved for some one (dat. of attribute)

insidēre locum = to *settle* in a place (to *take possession* of)
insidēre locum = to be *settled* in a place (to have and *keep possession* of)
potiri loco = to *enjoy the possession* of a place

Self-Examination Questions and Exercises.

What does the Latin adverb qualify? Give examples of its various qualifications. Under what circumstances may an adverb be used to qualify a substantive? How are the following adverbs used—*partim*, *ita*, *sic*, *satis*, *malè*, *parum?* Give examples. Distinguish *sic* from *ita*, and account for the difference according to derivation. Distinguish *consulo* with the accusative and *consulo* with the dative and *consulo* with the preposition *in* with the accusative. Distinguish *manet* with the accusative and *manet* with the dative, and distinguish *insidĕre* from *insidēre*. Distinguish the synonymous words for a *wound*, a *chain*, *vengeance*, *girl*, *life*, *fault*, a *bird of omen*, and an *abyss*.

Translate into English :—

Ut bina regum facies, ita corpora gentis. Dicto citiùs tumida æquora placat. Oderam multo pejus hunc quàm illum ipsum Clodium. Avidius quàm consultiùs animadvertebat in prætorem. Mors te saucium certissima manet. Quis hunc locum insidebit? Partim vulnerati, partim saucii erant. Ne utaris ultione, at vindictâ. Bibetur merum? Non virgo, at virago, illa fuit. Partim erant oscines, partim alites. Hocne est supplicium an mulcta? Compedes afferam tibi an manicas? Tibi parùm consulam, si hoc faciam. Hoc vinum tibi satis placebit. Adeo amans erat, ut semper amaturus putatus sit. Permulti circà reges, Romanum imperatorem, consulebant. Inter duo simul bella, binæ gentes pœne perferunt. Haud ita multum prædæ militibus datum fuerat. Homo fuit satis elegans et parum fortis. Amicus meus male gratus fuit. Ita me Dii ament, male sanus mihi visus est. Vulnusne an cicatricem hoc in corpore jacente jam video? Quid est facilius latu, ulcus an plaga? Hoc est vitium an culpa? Quot mendas, et quot maculas invenire poteras? Nulla magnopere clade acccpta consules ad Romam, neque vulnerati, neque saucii, rediерunt. Mirabile dictu, tibi sic manebit. Fabius Pictor Delphos ad oraculum missus est scitatum quibus precibus deos possent placare.

Translate into Latin :—

So may the gods love me, this is not a scar but a wound. It is in this way that you should consult for the interest of the state. What terrible blow (use *plaga*) awaits you, O consul! They went to bed mortally wounded. Will the citizens take proceedings against the unjust magistrate? (Yes.) In that way will they manage the business, so that they will not consult the interest of their parents. He hardly ever goes to the senate without some stain on his character (use *mŏres*). Will he consult the doctor, wounded as he is to the death? Is the maiden a masculine woman? Is this an abyss or a whirlpool which I see? Will the soldiers of the conqueror ever settle in this most fortified place (use *munitissimus* = most fortified). I shall not turn my attention to any other person. Let the slave bring to me fetters for the feet, not manacles for the hand, and that very quickly. Is this punishment retaliation, or is it angry revenge? Can you use unmixed wine without any fear of the penalty to one drinking it? More cautiously than justly he will avoid all corporal punishment. Is it vice, or fault, or crime, or sin, that will bring just vengeance to him? Is pecuniary punishment enough for the sin which he has committed against God and the crime which he has committed against man? (use *committere in* with the accusative cases). There can be no life to any man without the means of life, can there? (use *num*). This bodily punishment is retaliation, not just vengeance for the fault I committed against ye.

XI.

Spinning and Weaving Machinery.

The production of textile fabrics from the raw material, whether cotton, silk, linen, or wool, consists of a succession of operations, in some of which the machinery employed is probably more complicated than that used in any other manufacture. When viewed in a general way, the differences of treatment to suit the fibre employed are so slight, that it will be convenient for us to confine our attention to the machinery as specially adapted to the manufacture of cotton.

The production of fabrics from the raw cotton consists in the main of two operations—namely, *spinning*, or the conversion of the fibre into thread or *yarn*, and *weaving*, by which process the yarn is interlaced to form the required cloth.

The fibres are first freed as far as possible from foreign matter, and thoroughly mixed so that the yarn may be as uniform as possible throughout its length. After this preliminary treatment, the first step towards the preparation of the yarn consists in making the fibres parallel, which is effected by means of the "carding machine." This consists of several wooden rollers, each covered with leather or cloth which has short, stiff, though fine wires, projecting from its surface like the bristles of a brush, except that each wire stands out at an appreciable and regular distance from its neighbour. These circular wire brushes revolve rapidly in opposite directions; and the cotton introduced at one end is quickly passed on from roller to roller, and is then received on another roller called the "doffer," from which it passes through a funnel-shaped opening, and is received in a tin can. Fig. 34 is a representation of a carding machine.

The "combing machine," invented by M. Heilman, and patented by him in 1846, is a much more effective apparatus than that just described, and is generally employed for the production of the finest yarns. It consists essentially of a cylindrical comb, with teeth of gradually increasing fineness; and has many

appliances for facilitating the "combing" that we have not space to refer to.

The thick loose thread that collects in the can, as shown in the figure, is next passed several times through a drawing machine, by which it is rendered still more homogeneous and more firm and compact. The principle of this machine we owe to Arkwright, who took out a patent for in it 1769, and consists in stretching the fillet of cotton as it is drawn along by several pairs of rollers, the subsequent pairs revolving more rapidly than the preceding. This important action will perhaps be rendered more clear by an example. The bundle of fibres that constitutes the coarse thread given off by the carding machine is passed between a pair of rollers revolving at a certain rate; the thread then passes between another pair of rollers which we will suppose to revolve at twice the rate of the first pair; so that it is taken by the second pair at twice the rate that it is being given by the first. The thread must obviously by this treatment be drawn out to twice its previous length; and this stretching is accompanied by a corresponding increase in fineness which would soon result in breakage. But the object of the drawing is not so much to make the "sliver" (as the cotton is called at this stage) fine, as to secure a greater uniformity of structure, so the drawing is always accompanied by the operation called "doubling," which consists in folding the fillet of cotton upon itself. The general appearance of a drawing frame is no doubt familiar to many of our readers.

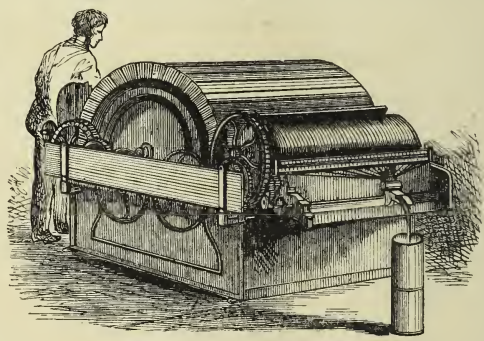


FIG. 34.—CARDING MACHINE.

The drawing is continued by the "roving machine," which also gives the thread or "rove" a slight twist as it is being delivered into the can that receives it. It is then wound upon bobbins, and is ready for the operation technically called "spinning"; for all the treatment that it has so far undergone is merely preparatory.

Spinning is an operation of very great antiquity; but until the middle of the last century the only assistance that the worker had at his command was the common spinning-wheel, by which only one thread could be produced at a time. As soon as the foreign demand for English cotton goods began to grow, the weavers found it well nigh impossible to keep themselves supplied with yarn, although in Lancashire alone there were 50,000 spindles, each requiring the whole time of one spinner. About 1764, Hargreave invented his "spinning-jenny," by which eight threads could be produced simultaneously; and about 1767 Arkwright brought out his method of spinning by rollers, the principle of which has already been described. The machine employed by Arkwright, which also gave the yarn the necessary twist, and wound it upon the bobbins, was the "throstle" or "water frame," the action of which is continuous, and puts so great a strain upon the yarn, that none but the coarser and stronger varieties can be produced by its means.

The yarn is not so strained by the spinning-wheel or the spinning-jenny, for the action of these contrivances is intermittent,—a certain length of thread first being spun, then wound upon the bobbin, the spinning and winding being continued alternately.

Shortly after Arkwright's invention became known, Crompton combined its advantages with those of the spinning-jenny in the complex machine called the "mule" or "mule-jenny."

The earliest mules carried thirty spindles each, but, such has been the extraordinary advance in connection with them, as well as other spinning machines, that those of the present day carry from 1000 to 2000.

The mule consists of two parts: the "head," which is fixed, and supports the spindles with the threads ready for spinning, and the rollers that stretch the threads; and the "carriage" which runs upon rails, and carries the spindles upon which the spun threads are wound, and which by their rotation give the required twist to the yarn. As stated above, the action is intermittent, consisting of two distinct series of operations. In the first place the carriage is drawn away, the threads at the same time being spun and twisted; these actions then stop while the carriage is run in, and the spun threads wound upon the spindles. The first mules were worked by hand, but now they are invariably self-acting; and the improvements that have been introduced from time to time have made this piece of mechanism so complicated, that the reader must be referred to more extensive works for further details.

After spinning the yarn is "dressed," the fine fibres projecting from it being laid even with the thread, that it may be better able to stand the friction necessary in weaving.

Weaving is an operation that has been practised from the very earliest times, and consists in interlacing threads so as to form cloth. Basket-making is a species of weaving; and there is little doubt but that the intertwining of the twigs furnishes a somewhat homely example of the method pursued by the earliest weavers. Darning also is a species of hand-weaving; the use of the needle being to facilitate the manipulation of the thread, which has not sufficient stiffness in itself. A piece of wire gauze gives another good illustration. The disposition of the threads in plain weaving is shown in fig. 35, each thread passing alter-

nately above and below those that it crosses at right angles. The frame on which the threads are stretched constitutes the earliest form of "loom," an apparatus stated to have been invented by the Egyptians.

The first operation in weaving is to arrange the parallel threads that run lengthways through the entire piece of stuff (and constitute the "warp"), and the second consists in threading the "woof" or "weft" in and out across the warp from side to side until the whole piece is woven. Thus it will be seen that the threads constituting the warp have each a loose end at both ends of the piece of cloth; so that the ends of the piece are "raw" edges, and easily unravelled; but that the weft is a continuous thread turning back whenever it reaches the side of the piece of cloth so as to form a "selvage" that cannot be unravelled.

FIG. 35.

The weft is carried by a "shuttle"—that is a piece of wood pointed at both ends and hollowed out, so that it may contain a reel on which the weft is wound (*see* fig. 36). The shuttle may be compared to a darning needle that carries its own reel of cotton within itself, and it might be pushed in and out the warp by raising each alternate thread of the warp, and pushing the shuttle under it. The chief object of the loom, however, is to raise the alternate threads of the warp all at once, to allow of the shuttle being *thrown* right across the warp, then to lower these threads and raise the others ready for the return of the shuttle. This action is realized by the use of "heddles," which are frames each containing a row of vertical strings looped in the middle. For plain weaving, each alternate thread of the warp is passed respectively through one of the loops in one of the heddles, and the heddles are raised alternately by cords connected with a treadle. Figure 37 shows the vertical strings of the heddles and the horizontal threads of the warp, the second, fourth, etc., threads being raised so as to give a space, or "shed," through which the shuttle is to be thrown. The thread of weft that the shuttle leaves behind it is pressed up close to the last thread by a comb-like apparatus called a "lay," the teeth of which pass between the threads of the warp.

FIG. 36.

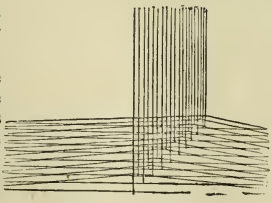


FIG. 37.

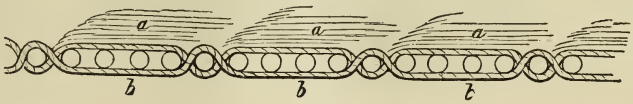


FIG. 38.

For the production of twills and other similar fabrics, the weft is not passed alternately over and under each thread of the warp, but some threads of the warp are grouped together as shown in fig. 38. It is by similar means that the patterns are produced on white tablecloths and twills, and by working in this way with a weft consisting of alternate threads of different colours, it will be seen that the pattern on one side will be of the same colour as the ground on the other. For pattern weaving it is necessary to increase the number of heddles, so that the warp threads may be attached to them in appropriate groups; and this extra manipulation requires the employment of a draw-boy, who draws up the heddles as necessary. Pattern weaving has been much facilitated by the apparatus called the Jacquard loom, so named after its inventor, a representation of which is given in fig. 39.

Power looms, as the name implies, are such as are driven by some motor instead of being worked by hand. The invention of the power loom is due to Cartwright, who took out his patents for it in the years 1785—1787; but it was not until the beginning of the present century that it began to come into general use. Cartwright took out no fewer than ten different patents connected with his process, one of which, dated in April 1790, was for the combing of wool. The first mill on his plan, which contained five hundred of his looms, was destroyed by a wilful fire; and for nineteen years, after a large expenditure, this great mechanical genius scarcely derived any advantage from his important inventions, but in 1809 Parliament voted him a grant of £10,000, as expressed in the Act, "for the good service Dr. Cartwright has rendered the public by his inventions for weaving," thus enabling him to spend his latter days in comfort.

END OF "MACHINES AND MACHINERY."

XII.

The Second Period of English Literature (*continued*).

The earlier part of the second period of English literature was enriched by some very remarkable productions of north country poets: indeed, the Scots appear far in advance of their English contemporaries. Warton justly speaks of the Scottish writers of this period as possessing "a degree of sentiment and spirit, a command of phraseology, and a fertility of

imagination, not to be found in any English poet since Chaucer and Lydgate."

William Dunbar (1465–1530).

William Dunbar, a native of Salton in East Lothian, is entitled to the first place among these Scottish poets; indeed, Sir Walter Scott pronounces him "unrivalled by any poet that Scotland has yet produced," though, singularly enough, his works were never printed till the beginning of the eighteenth century. Like Chaucer, whom he resembles in his genial though somewhat coarse humour, and in his exquisite power of portraying vividly by a few masterly touches, Dunbar was a traveller; but, unlike the father of English poetry, he belonged to the Church; for Dunbar was a Franciscan friar; but a courtier withal, and a man of the world—one whom, as of Chaucer's immortal cleric, it might be said:

> "This ilke monk lette olde things pace,
> And held after the newe world the trace."

A courtier, and a not unsuccessful one, he was patronised by James IV., who employed him, as Chaucer had been employed, on various embassies abroad, even as far as Italy and Spain, and pensioned him for his services. Dunbar, who had quitted the Franciscan profession of preaching for the charms of a court life, does not seem to have been satisfied with the change, or to have found dependence in the favour of princes much more attractive than a livelihood drawn from the alms of the charitable. Dunbar's genius was both didactic and satirical; his style energetic, and his morality replete with strong sense.

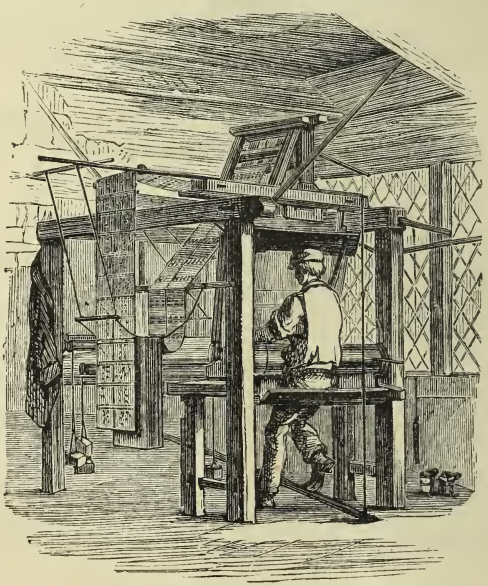


FIG. 39.—JACQUARD LOOM (*see* p. 873).

"The Thistle and the Rose."

His chief work is *The Thistle and the Rose.* This is a poem written on the marriage of James IV. with Margaret, daughter of Henry VII. of England; typified by the union of the Scottish thistle with the English rose. The work is allegorical throughout. Nature is represented as forbidding Eolus and Neptune to retard the progress of Spring, and as summoning birds and beasts to her presence on the first of May; the lion of Scotland—the "ruddy lion" that "ramped in gold," as Sir Walter Scott tells us in *Marmion*—is strongest among the beasts. He is surrounded in heraldic fashion with *fleurs-de-lys:*

> "Ryght strong of corps, of fassoun fair but feir,
> Lusty of shaip, lycht of deliverance,
> Reid of his cullour as the ruby glance,
> In field of gold he stude full mychtely,
> With floure de lucis sirculit lustely."

He receives a crown, as king of the beasts. The Thistle is likewise crowned for his warlike prowess, and the Rose is to be honoured above all other flowers, "considering that no flower is so perfite, so full of virtue, pleasaunce, and delight. so full of blissful angelic beauty, imperial birth, honour, and dignity. The opening stanza of the poem irresistibly calls to mind the beginning of Chaucer's *Canterbury Tales.* Chaucer describes how "April with his shoures sote (sweet) the drought of March hath pierced to the root"—how the flowers spring and the "smale foules maken melodie." Dunbar's poem begins:

> "Quhen Merche was with variand windis past,
> And Apperyll had with her silver shouris
> Tane leif of Nature, with ane orient blast,
> And lusty May, that muddir is of flouris
> Had maid the birdis to begyn thair houris,
> Amang the tendir odouris reid and quhyt,
> Quhois harmany to heir it was delyt."

The second in importance of Dunbar's poems, *The Golden Terge,* represents Venus, the queen of love, marshalling a number of her attendants, youthful and beautiful ladies all, to shoot their arrows against the poet, who is defended by Reason with the golden terge or shield. "But Reason bare the Terge with sic constance, their scharp essay might do me no deirance." But a magical powder is thrown by "Presence into Reason's eyes," Beauty takes the poet prisoner, Fair Calling and Cherishing and New Acquaintance combine to receive him, and at last he is delivered over to Grief. The allegory represents the triumph of love over reason. The poet inserts some lines highly eulogistic of "reverend Chaucer," "moral Gower," and "Lydgate laureate," whose golden pens have illuminated the language, and "over-gilt our speech." *The Dance of the Seven Deadly Sins through Hell* is in another style, far less laboured and highly picturesque.

"The Dance of the Deadly Sins."

Mahomet, or Mahoun, the incarnation of evil to the people of that time, commands a dance, which is executed by the seven deadly sins. Pride appears in gorgeous array, Anger passes by with his hand on his knife, Sloth has to be twice summoned before he will come, Gluttony is followed by a rout as insatiable as the daughter of the horse-leech—even the draughts of melted lead administered to the demons do not stop their clamour for food and drink.

"Than the fowll monster GLUTTONY,
Of wame (stomach) unsasiable and gredy,
To daunce syn did him dress:
Him followit mony fowll drunckhart,
With can and collop, cop (cup) and quart,
In surfett and excess.
Full many a waistless wally-drag (outcast),
With waimis unweildable did furth wag,
In creische (fat) that did incress:
Drink, ay thay cryit with mony a gaip,
The feynds gave them hait leid (hot lead) to lap,
Thair lovery (appetite) was na less."

In a broader style of the comic is the poem *The Two Married Women and the Widow*, a humorous conversation between three lively ladies. *The Merle and Nightingale* is also full of merit.

ROBERT HENRYSONE, a Benedictine monk and a schoolmaster, of whose personal history hardly anything is known, is remembered as the author of the earliest pastoral poem of Scotland, *Robene and Makyne*. He wrote a series of thirteen fables, of which the *Vponlands Mouse* and the *Burgesse Mouse*, the oft-edited *Town and Country Mouse*, is the chief. Henrysone's version is full of humorous description. The stanza that describes the town mouse endeavouring to cheer her country friend, who has fallen into a swoon for very fear, at the interruption of their feast, is capital. The town mouse says:—

R. Henrysone's "Robene and Makyne."

"Uponlands Mouse" and "Burgesse Mouse."

"Why lie ye thus? Rise up, my sister dear,
Come to your meat; this peril is o'erpast."
The other answered with a heavy cheer,
"I may naught eat, sae sair I am aghast,
Lever I had this forty dayis fast,
With water kail, and green beans and peas,
Than all your feast with this dread and disease."

And the moral most appropriately tells us:

"Blissed be simple life, withouten dreid,
Blissed be sober feaste in quieté;
Who has eneuch, of no more does he neid,
Though it be little into quantity."

Henrysone also wrote a sequel to Chaucer's *Troilus and Cresseide*, under the title *The Testament of Cresseide*.

GAWAIN DOUGLAS, Bishop of Dunkeld, a son of the famous Earl of Angus, popularly known as Archibald Bell-the-Cat, and Sir DAVID LINDSAY, LORD LYON, King-at-Arms of Scotland, were important among the poets of their time. The chief production of Douglas was an allegory, *The Palice of Honour*, intended for the edification of James IV. of Scotland, and bearing a great resemblance, in the general idea of the story and its treatment, to Bunyan's *Pilgrim's Progress*. He also made a translation of Virgil's *Æneid* into Scottish heroic verse—a work of no little importance for those days. Douglas has neither the vigour nor the poetical fancy of Dunbar. His verses are tame and flat in comparison with the northern Chaucer's nervous lines, and Hallam rightly designates the character of his original poetry as "that of the middle ages in general—prolix, though sometimes animated, descriptive of general objects." Douglas prefixed to each book of Virgil an original metrical prologue. The

Bishop Gawain Douglas (1475–1522).

"The Palace of Honour."

Virgil's "Æneid."

following lines, taken from the prologue to the sixth book, will give an idea of the style and orthography of Douglas' works:—

"Quhil schortlie, with the blesand torche of day,
Abulzeit in his lemand fresche array,
Furth of his palice ryall ischit Phebus,
With golden croun and visage glorious,
Crisp haris, bricht as chrissolite or thopas;
For quhais hew mycht nane behold his face:
The firie sparkis brasting from his ene,
To purge the air, and gilt the tender grene.—
The auriat phanis of his trone soverane
With glitter and glance overspred the octiane
The large fludis lemand of all licht,
Bot with ane blenk of his supernal sicht,
For to behald, it was ane glore to se
The stabillyt wyndis, and the calmyt se;
The soft sessoun, the firmament serene;
The loune illuminate are, and firth amene."

Translated into modern prose these lines would read as follows:—

"While shortly, apparelled in his luminous array, Phœbus, bearing the blazing torch of day, issued from his royal palace; with a golden crown, glorious visage, curled locks bright as the chrysolite or topaz, and with a radiance intolerable.—The fiery sparks, bursting from his eyes, purged the air, and gilded the new verdure.—The golden vanes of his throne covered the ocean with a glittering glance, and the broad waters were all in a blaze, at the first glimpse of his appearance. It was glorious to see the winds appeased, the sea becalmed, the soft season, the serene firmament, the still air, and the beauty of the watery scene."

A small Latin *History of Scotland* should also be mentioned among Douglas's books.

SIR DAVID LINDSAY wrote *The Dreme*. In many respects this poem reminds us of Dante's *Divine Comedy*. The poet, accompanied, or rather guided, by the good lady Remembrance, visits Hell, Purgatory, and Paradise. His other work is *The Monarchy*, an account of various kingdoms, in the form of a dialogue between Experience and the poet, who appears as a courtier. Lindsay strongly censures the clergy for their slothful and vicious lives; nor does he spare the court in his satire. In the *Dreme*, Remembrance carrying the poet into the centre of the earth, where Hell is laid open to his view, and where he sees Judas, Dathan and Abiram, Nero, Pharaoh, Pontius Pilate, and many other sinners of ancient days undergoing punishment, is evidently suggested by the *Inferno* of Dante, where the poet visits the abode of the lost in company with the Roman Virgil. Then a visit to Purgatory, which is next afforded to the poet, is thus described:—

Sir David Lindsay, (ab. 1490 to 1568).

"A litle above that dolorous dungeon,
We enterit in ane countre full of cair;
Quhare that we saw mony one legioun
Gretand (weeping) and grouland with many ruthfull rair (roar),
Quhat place is this, quod I, of blis so bair?
Scho answerit and said, Purgatorie,
Qhuilk purgis saulis or they cum to glorie."

Quitting this dolorous dungeon, they ascend to the sphere of the moon, "that lusty lamp and lanterne of the hevin," and at length reach the Empyreal, where the throne of the Almighty stands surrounded by angels, with saints, patriarchs, martyrs, and evangelists forming an

outer ring. With something of the effect of bathos, the poet passes at once from Paradise to Scotland, personified by Sir Commonwealth, who comes hurrying to them "with ane richt melancholious countenance," for his "raiment was all raggit, rewin, and rent, with visage leyne, as he had fastit Lent." And the speech of Sir Commonwealth is in keeping with his "outward favour," for he gives a most dolorous account of the degeneracy of manners in Scotland under James V., and of the degeneracy of the times. In the sequel some very outspoken and caustic advice is given to the king, who is exhorted to mend his ways and be a better man. In *The Monarchy* Experience is aptly depicted as

Severe and outspoken satire.

> "One agit man, quhilk drew me near,
> Quhose beard was weil thre quarters lang,
> His hair down o'er his shoulders hung,
> The ghylke as very snaw was whyte,
> Quhome to beholde I thocht delyte."

And a very edifying and sensible discourse do the courtier and Experience there hold together, touching the monarchies of all times, Jerusalem and the Papal see each having a place in the narrative.

Other works of Lindsay are *The Complaynt of the King's Papingo*, *The Play of the Three Estates*, *Kitter's Confession*, and *The History of Squire Meldrum*.

SOUND, LIGHT, AND HEAT.

XII.

LIGHT.

THE formation of images in a convex mirror will be readily understood by the reader who has mastered the conditions under which images are formed by concave reflectors. A simple geometrical construction will show that all images formed by a convex mirror are virtual. Parallel rays are reflected

Formation of images in convex mirrors.

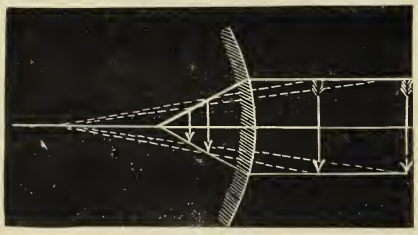


FIG. 58.

from the mirror in the form of a diverging cone, and being produced backwards they intersect behind the mirror at a point apparently halfway between the mirror and the centre of curvature; this is the principal focus. The images formed by convex mirrors are always erect and diminished. Fig. 58 explains their formation.

When a ray of light passes from one transparent medium to another, it is bent out of its straight paths, or "refracted." This is well shown when a beam of light is admitted through a small aperture into a darkened room, and allowed to fall upon the surface of water contained in a rectangular glass vessel. (*See* fig. 59.)

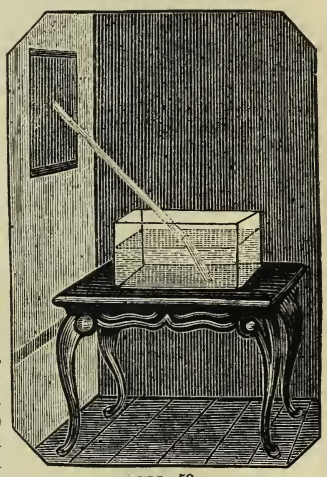


FIG. 59.

When the beam reaches the surface of the water a portion of it undergoes reflexion in the ordinary way; the other portion enters the water, and in so doing is bent downwards instead of continuing its course in a straight line, which it would do if the vessel contained only air; this bending of the ray out of its straight path is termed *refraction*.

A very simple and well-known experiment exhibits the phenomenon of refraction in a striking manner. Lay at the bottom of a basin a coin,—say a shilling,—and then, placing the basin upon a table, walk backwards from it until you just lose sight of the shilling. Now let a friend pour water very gently into the basin so as not

Experimental illustrations.

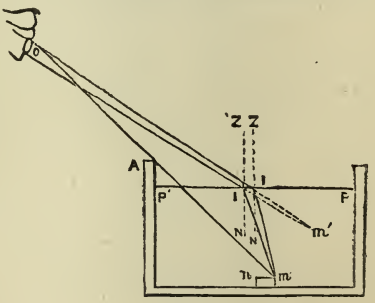


FIG. 60.

to move the coin: it will gradually come into view, and when sufficient water has been poured into the basin the whole of the shilling will be seen by the observer, and will appear to be somewhat raised up from the bottom of the basin. The reason of this curious phenomenon will be understood upon reference to fig. 60.

Here *m n* represents the coin at the bottom of the vessel, and, when the latter only contains air, the line *m* A represents the path of a ray of light from the edge of the coin, and, this passing above the eye, the coin is invisible. When water is poured into the vessel the rays

from *m* pass up to the surface of the water in a much steeper path ; at I they are refracted, and thus enter the eye at O. Now, the human brain conceives of the position of objects as being in the direction from which the rays of light appear to come, and the coin will therefore be seen at *m'*. A similar explanation applies to the bent appearance which the end of a stick has when thrust into water.

The law of refraction.

A reference to fig. 61 will make clear the important law by which refraction is governed. Let I be the surface where two different media, such as air and water, meet, and let RI be a ray of light falling upon I. Instead of continuing

FIG. 61.

from I to R in a straight line, it is bent downwards towards the perpendicular, and follows the path SI. The angle at I which the incident ray makes with the perdendicular is the *angle of incidence* ; the angle which the refracted ray makes with the perpendicular is the *angle of refraction.* Let lines be drawn at right angles from the perpendicular to the points where the circle is cut by the incident and refracted rays respectively ; it will be found in the case of air and water that the length of these lines is always as 4 to 3 ; $\frac{4}{3}$ or $1\frac{1}{3}$ is therefore said to be the *index of refraction* for air and water. In like manner other media have different indices of refraction. The law of refraction is stated in trigonometrical language to be as follows :—*The sine of the angle of incidence divided by the sine of the angle of refraction is always a constant quantity.* What the ratio between these two sines is for any given media is expressed by the index of refraction for those media : with air to water it is, as stated above, $\frac{4}{3}$; from air to glass it is $\frac{3}{2}$ or $1\frac{1}{2}$.

Meaning of the term "sine of an angle."

In order to make the meaning of the foregoing law perfectly clear a little more explanation is necessary. The sine of an angle is the number obtained by dividing the length of the perpendicular by the length of the hypotenuse of the triangle, and is therefore a *ratio*, varying with the angle. In the figure the sine of the angle, SIP, will be the length of the SP divided by the length of SI; in the same way the sine of the angle, R'I'P', will be R'P' divided by R'I. These results may be more concisely expressed thus :—Sine $SIP = \frac{SP}{SI}$; Sine $R'IP' = \frac{R'P'}{R'I}$. But with the construction in the figure SI and R'I are both radii of the same circle, and will therefore be equal to one another ; consequently in considering the ratio of these two sines we may cancel SI and S'I, and the ratio of the two sines will be the same as that between the two perpendiculars R'S' and SP.

Relative and absolute indices of refraction.

The ratio of the sine of the angle of incidence to the sine of the angle of refraction, when a ray of light passes from one medium to another, is known as the *relative* index of refraction, but when a ray of light passes from a vacuum into any medium, the index of refraction is termed the *absolute* index for the particular medium employed. The relative index of refraction from any medium A to any other B is always equal to the absolute index of B divided by the absolute index of A. In considering the refraction of light when passing from air into solids or liquids, the absolute index of air is so small that for all practical purposes it may be neglected.

Total reflexion.

When we consider the passage of a ray of light from a less refractive to a more refractive medium there must always be, for every angle of incidence, a corresponding angle of refraction, which is determined by the law above given. Upon considering the passage of a ray of light in the reverse direction, this does not always apply, for in this case the angle of incidence is always less than the angle of refraction, and therefore as the former is increased the latter will increase more rapidly, and will at length become greater than a right angle, when the refracted ray will not leave the more refractive medium, but will become *totally reflected.* This will be better understood on reference to fig. 62.

Let CD be a glass vessel containing water, and A and B small mirrors. If a beam of light be reflected by A vertically downwards upon B, it will, if the angle at which the latter is placed be small, be reflected towards the surface of the water at such an obliquity that part of it will be there reflected in the ordinary way and

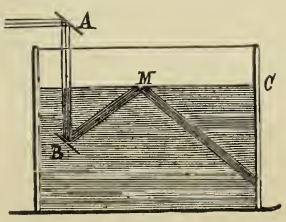


FIG. 62.

the other part passing into the air will suffer refraction. If, however, the mirror be placed at a considerable angle, the ray, BM, will reach the surface of the water so obliquely that the angle of refraction will be greater than 90°, and the ray of light will not suffer refraction in the ordinary sense, but will be *totally reflected* in the direction MD, so that an object at B would be seen by an eye at D, reflected as in a mirror at M. In this case the image would be as bright as the object, there being no loss of light at the reflecting surface by irregular dispersion, as in all ordinary mirrors.

It will be easily seen upon consideration that if the inclination of the mirror, B, be slowly increased from a small angle, the ray, BM, will, at a certain inclination of B, reach the surface of the water at such an angle that the refracted ray will just skim the surface in the direction MC—that is, the angle of refraction will be a right angle. The angle at which the incident beam must reach the surface in order that this may occur is termed the *critical angle*; beyond that angle refraction ceases, and total reflexion must occur. The critical angle for water is 48° 35′, for glass 40° 49′, and for the diamond 23° 43′.

Critical angle.

The phenomena of the mirage and similar natural optical illusions are due to total reflexion. In the case of the mirage the air near the ground becomes greatly heated, and in ascending the various strata of air are of different densities; this causes a series of refractions of the rays of light, which eventually produces total reflexion. Several simple experiments also illustrate the phenomena of total reflexion and refraction. Place a spoon obliquely in a glass, and it will appear to be bent or broken at the surface of the water; place a test-tube in water in an inclined position, it will shine like burnished silver; hold a glass of water with a spoon in it above the level of the eye and look up at it, the under side of the surface of the water will shine like burnished silver, and in it will be seen reflected the lower part of the spoon. (*See* fig. 63.)

The mirage.

FIG. 63.

A useful instrument which is often employed to facilitate the sketching of microscopic and other objects, is known as the *camera lucida*, which in its most common form is shown in figs. 64 and 65.

The camera lucida.

It consists essentially of a totally reflecting prism, having four angles, one of which is 90°, the opposite one 135°, and the other two each 67° 30′. One of the two faces containing the right angle is turned towards the object it is desired to sketch, and it is obvious that a ray of light, *x r*, falling upon this face, will be at an angle much greater than the critical angle of glass with the face, *c d*: it will therefore be totally reflected to the next face, *da*; here again the ray will be totally reflected to the fourth face of the prism, whence it emerges. The object

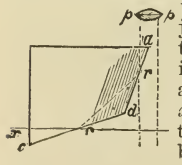


FIG. 64.

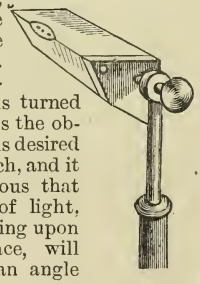


FIG. 65.

of having two total reflexions is to ensure an erect image; a single reflexion would give an inverted image. In using the camera lucida the eye is placed so as to receive the rays from *a*, which will give a virtual image seen at right angles to the object; direct rays of light will also be perceived coming in a parallel direction outside the prism, and in this way the reflected image is projected upon a sheet of paper placed to receive it, and upon which the drawing can be made.

As light undergoes refraction in passing from air to glass, it is obvious that the glass windows through which we so constantly view objects must have some effect, though slight, upon the apparent position of those objects. In fig. 66 we have represented two rays of light coming from

Refraction by parallel surfaces.

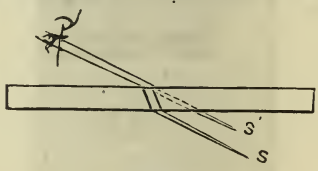


FIG. 66.

an object, S, and passing through a plate of glass before reaching the eye. In passing through the latter the rays become less oblique, but their original angle is restored upon reaching the upper surface of the glass; the effect of the latter is obviously to produce a small *lateral* displacement, so that the image is seen at S′ instead of S, but the refracted rays are parallel to the incident ones. It is therefore obvious that objects which are seen obliquely through a plate of glass are displaced laterally from their true positions; with ordinary thin window glass this displacement is so slight as to be practically unnoticeable.

If a candle be held in front of a looking-glass so that the rays fall obliquely upon the glass, several images of the candle, varying in brightness from each other, will be seen. (*See* fig. 67.) This phenomenon will be explained by a consideration of fig. 68. If S be a luminous point, placed before a transparent plate with parallel faces, of the rays which fall upon the plate some will be reflected from the front, and will give rise to an image apparently at S′; another portion will enter the plate and be reflected at the back, and will also emerge and undergo refraction at the front, giving rise to a second image, S°. Another portion will undergo internal reflexion at the front, and again at the back, and then emerging in front will form a third image, S¹, and the same

Multiple images by reflexion.

FIG. 67.

process being repeated several times, further images, as s_2, s_3, etc., may be produced. If the glass be silvered at the back the second image

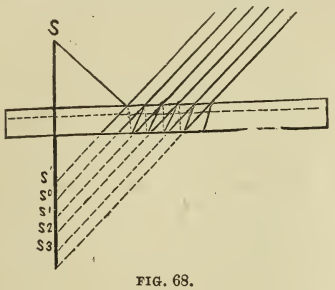


FIG. 68.

is brighter than the rest when the incident ray is nearly at right angles, but as the angle of the incident ray increases the first image gets brighter and brighter, and eventually surpasses the second; this is owing to the fact that the reflecting power of glass increases with the angle of incidence.

A prism in optics is any portion of a transparent body lying between two inclined planes; that is to say, a prism is a kind of wedge, and the section of such a prism must obviously be a triangle, but the prisms we are about to consider are not right-angled. In fig. 69 we have represented a section of a prism with the course which a ray of light takes in passing through it. In passing from a less refractive medium than glass,—as, for instance, air, — the ray upon entering the prism is bent *towards* the perpendicular, and on leaving will be bent *away* from the perpendicular, but in both cases it will be seen that the ray is bent *towards the base of the prism*. In the figure S I is the incident ray, E B the emergent ray, while the dotted lines represent the perpendiculars to the surfaces of the prism. In practice the prism is usually placed in such a position that I E, the refracted ray through the prism, makes equal angles with the two faces at which refraction occurs. When white light is used the rays are not only refracted but dispersed in a manner which will be fully explained later on.

Refraction through a prism.

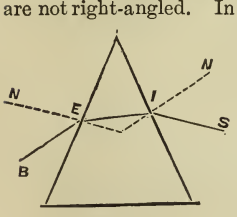


FIG. 69.

When a beam of light passes through a prism it is found there is a certain mean position of the prism in which the transmitted light has a smaller deviation than for other positions on either side of this mean point; when the prism is in this position a small rotation has no sensible effect on the amount of deviation. This position is known as that of *minimum deviation*, and is found to be that in which the ray in the interior of the prism forms equal angles with the surfaces at which it enters and emerges.

Minimum deviation.

LI.

ROME (*continued*).

EVER since the time of Pompeius, the splendour of the East had dazzled the imaginations of the Romans. The oldest civilizations, the greatest wealth, the highest forms of art and literature, and the most intelligent people, were to be found in that part of the empire. Constantine, who cared little for Rome, and spent most of his time away from it, determined to fix his capital in the East. He chose for its site the fortress of Byzantium, to which he had once pursued a rival, and had marked its unrivalled position on the Bosphorus. There he built a city, the walls of which enclosed an area equal to that of Rome, and called it after himself, *Constantinople*, or the City of Constantine. Here he created a new senate and new officials, leaving Rome and its ancient senate to themselves. Rome, no longer the seat of government, was henceforth little more than a great provincial capital, which the emperors occasionally visited at the head of their armies, but from which the affairs of the world were no longer directed.

Founding of Constantinople.

Seat of government transferred from Rome.

Julian, the nephew of Constantine, tried to bring back the old pagan religions during his short reign; but after his death the movement died out, and Christianity met with no further check. Not long after his death the barbarians began to break in on all sides. The Goths, driven from Dacia by the fierce Huns, who now poured into Europe from the plains of northern Asia, were compelled to cross the Danube into Roman territory; and in a great battle killed the emperor Valens (A.D. 378), and carried all before them. The next emperor, Theodosius, reduced them to a kind of submission, but was obliged to let them settle within the empire. In the year A.D. 410, the Goths, under their king, Alaric, besieged and took Rome itself, just eight hundred years after its sack by Brennus and his Gauls. Athaulf, the successor of Alaric, made peace with the Romans; and took his warriors on to Spain, where he settled down, and founded a Gothic kingdom practically independent of the empire. But Goths and Romans alike were soon attacked by the Huns,—the most ferocious and terrible of all the disturbers of peace in Europe. Under their leader, Attila, they now set out from the country they had lately occupied, which to this day bears their name and retains some of their warlike characteristics,—the country known to us as Hungary.

Julian, A.D. 361—364.

Barbarian invasions.

Goths settle inside the empire, A.D. 378.

Goths take Rome, A.D. 410.

Goths settle in Spain, A.D. 420.

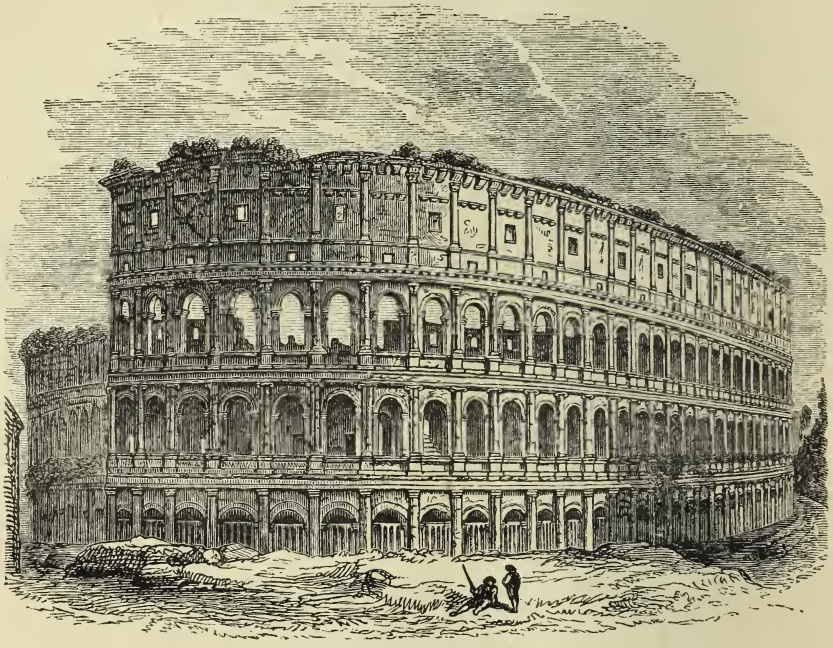
Huns.

Attila, A.D. 433—453.

Attila called himself "the scourge of God," and endeavoured to prove his right to the title by spreading death, fire, and destruction wherever he appeared. After "scourging" in this fashion the north-eastern portions of the empire, he passed on to Gaul, crossing the Rhine at Strasburg and ravaging the country as far as Orleans. Here Aetius, "the last of the Romans," as he has been called, met him with a great army. Attila withdrew; but was followed by Aetius, and defeated at Châlons, A.D. 451. In the following year he entered Italy; but did not go further south than Padua and Verona.

Founding of Venice.

The Veneti, who dwelt in this part of Italy, fled to the marshes and islands of the Adriatic, and founded there the city of Venice, afterwards the most powerful and richest city of the Mediterranean, and still the most beautiful. Attila died soon afterwards, and his army fell to pieces.



THE COLOSSEUM AT ROME.

Loss of the provinces.

But the other barbarians still pressed on; province after province of the empire fell under their power, and was ruled by their chiefs, who still called themselves the emperor's officers, but were in reality independent.

Spain and France.

The Goths were settled in Spain and the south of France, the Burgundians in central France, and the Franks in the north.

Britain.

The English were swarming into Britain, and driving out the Romans and their civilization far more completely than the invaders in other parts of the empire had done.

Africa.

The Vandals had got Africa; and under their king, Genseric, sacked the ill-fated Rome once more.

The Lombards.

The Lombards settled in north Italy, and gave their name to the lovely country which we know as Lombardy. From time to time the emperors of the East made a successful stand against their various enemies, and were able to protect at least their city. There were generally emperors of the West who had their headquarters in Italy, and exercised more or less authority over the west of Europe, while the emperors at Constantinople ruled the east.

Empire split into two.

In A.D. 476, Odoacer, at the head of a host of Germans, marched into Italy, and formally deposed the reigning "emperor of the West," and extinguished the western empire. Rome was henceforth governed by her bishops, or popes as they were called. Three centuries later, a Roman emperor, Charlemagne, was again formally crowned at Rome by the pope; and the title survived to his successors, but it was little more than nominal.

Nominal revival.

The eastern empire stood a thousand years longer. Its richest provinces in Asia and Africa were gradually wrung from it by the Arabs or other Mohammedan conquerors; and at last, having dwindled down to a small Greek kingdom, Constantinople was taken by the Turks, its present owners, in A.D. 1453, and the last remnant of the empire of the East disappeared.

Extinction of empire of the east by Turks, A.D. 1453.

The provinces of western Rome torn away from her by the barbarians grew gradually into the modern nations of western Europe.

All of them derive much of their laws and language and civilization directly from her. Spain, Portugal, France, and of course Italy, speak Latin, modified more or less. England owes less to Rome than the Continental nations, because the English had never come into close contact with the Romans in their native land, and when they settled in this country they quickly drove out or killed the representatives of Roman civilization, of which they understood nothing, and which therefore they were incapable of appreciating. But on the Continent men perceived the greatness of the civilization with which they were surrounded, and tried to adapt themselves in some measure to it. The powerful hold which Rome had taken over the minds of men is illustrated by the ready submission which they made in ecclesiastical matters to her bishops; and as the temporal power of her emperors passed away, a new and almost more imperious power, resting upon moral force, took its place, and guided the consciences of men for centuries after she had ceased to direct their armies.

Influence of Rome on them.

The Popes.

END OF "ANCIENT HISTORY."

KEY TO FRENCH EXERCISES.—X.

EXERCISE LV. (*page* 846).

1. "Wait for me under the elm-tree" is said of an appointment one does not intend to keep, of something that one does not wish to do. 2. The most pernicious error is to expect that God will wait for us. 3. The king, after having spoken to some of them, noticed at last that grey hat. 4. With the exception of you and me, sir, I do not think that any one would take into his head to run about the streets (to be abroad) at this time. 5. Let us beat (strike) the iron while it is hot. 6. He has fought several times in duels (he has fought several duels). 7. How often have the Guelfs and Ghibellines fought! 8. One should not challenge a madman. 9. You, favourite, you, grandee, distrust kings; their favour is slippery, one cannot rely upon it. 10. Theseus is dead, madam, and you alone doubt it. 11. I was guessing, my lord, that my crown was charming you at least as much as my person. 12. Pack off with all your gods Flora and pink-fingered Aurora. 13. Who knows how to pay his court, fashions himself to the morals of princes. 14. Mazarin was naturally fond of gambling; but he only played to enrich himself, and cheated as much as he could for the purpose of gaining. 15. One even saw on the grazing grounds, wolves disporting themselves in the midst of the sheep. 16. If you knew what it is to get a son married, you would excuse me for having been so long without writing. 17. O sister, marry philosophy. 18. This comes from dressing like a man of quality. 19. Those who were admiring her fortitude, lost theirs; those who were pitying her almost appeared the only ones to be pitied. 20. The spirit of infidelity mocks all that is most sacred.

EXERCISE LVI. (*page* 847).

1. Guillaume dit qu'il a bruiné tout le jour; a-t-il aussi bruiné toute la soirée? 2. Gautier dit qu'il grêle aussi souvent en Angleterre qu'en France; est-ce vrai? 3. En Angleterre il grêle le plus en hiver, et en France il grêle le plus en printemps; autrement il n'y a pas une grand différence entre les deux pays. 4. Quand il tonnait, Mme de Saint-Hérem se fourrait à quatre pattes sous un lit de repos. 5. Qu'il neige, grêle ou tonne, peu lui importe. 6. Fait-il froid dehors? Je crois bien; il gèle à pierre fendre. 7. Il gèle à Paris depuis près de huit jours. 8. Vous vous trompiez en supposant qu'il ne neigeait jamais à Athènes; il y est tombé plus d'un pied de neige l'hiver dernier. 9. Nous nous morfondions plus que nous ne l'avons jamais fait en Prusse; vous pouvez bien deviner qu'il n'y avait ni cheminées, ni calorifères, ni poêles même. 10. Les glaces, les neiges fondent, il dégèle depuis ce matin. 11. Vous espérez qu'il dégèlera; moi, j'espère qu'il gèlera, et qu'il gèlera à pierre fendre. 12. Quand il y va de vos plaisirs, tout le reste vous est égal. 13. Vous vous trompez; il n'y va pas de votre fortune, il y va de votre honneur. 14. S'il y allait réellement de mon honneur, tout le reste me serait égal. 15. Comme il ira de sa fortune, il fera attention. 16. Il y a des lois pour la société des abeilles; comment a-t-on pu penser qu'il n'y en avait pas pour la société des hommes? 17. Vous avez eu raison de vous fâcher; il y avait de quoi. 18. Il n'y a de pêches que de Montreuil. De quel Montreuil s'agit-il? Il y a deux ou trois Montreuils en France. Il s'agit de Montreuil près de Paris. 19. Quel temps fait-il? ne fait-il pas du brouillard?—Non, il fait beau. Croyez-vous qu'il (*or* que le temps) restera au beau?—J'en doute. 20. Ne vaut-il pas mieux, comme le dit Voltaire, avoir des douleurs que des remords?

XLVII.

THE TELESCOPE (*continued*).

ON EMPLOYING THE TELESCOPE.—Within the scope of the present pages it will be impracticable to give an account of the best methods of using a telescope; and indeed the only sure method of learning this is by actual experience, as all observers have their own preferences in this respect, often two selecting

almost diametrically opposite ways of arriving at the same end. A few suggestions may be of use, however.

Reflectors perform best in the open air, or at least in a situation where they are merely sheltered from the wind. From their form, they are always mounted on low stands, and can easily be covered with a flat roof not more than six feet high. The kind of observatory most suited to them is therefore one with a roof which runs back from over at least one half of the observatory. Refractors necessarily are mounted on much higher stands, so that they require being covered by a domed or drum-shaped observatory roof. This roof may be made, however, with an opening or shutter only four feet wide, so that the instrument and observer are far better covered than when using a reflector.

The most suitable series of magnifying powers for a telescope are 15, 30, 45, 60 and 90 to the inch of aperture: thus for a telescope of six inches aperture a set of eyepieces magnifying 90, 180, 270, 360, and 540 is all that is required. A very low power eyepiece with a large field of view, and about 40, is useful for magnifying or finding objects. The greater number of nebulæ, comets, and some few wide double stars, require the power of 15 to the inch of aperture; or if bright enough to bear it, as is the case with some comets and planetary nebulæ, the power of 45 to the inch may be used. For the sun, the power of 20 to the inch is the only one which will be of much service. Mercury and Venus in daylight will also require this power of 20. So will Saturn; but the satellites of Saturn will be best seen with the next higher power. Jupiter, Uranus, and Neptune will require the power of 45 to the inch, and at times Jupiter will bear even the next higher power. Most double stars will also be seen best with this eyepiece. Mars generally requires a power of 60 to the inch to show the markings well; it must also be used for Mercury and Venus when seen after sunset. The power of 90 is generally only of use for very close double stars. Sometimes, but very rarely, both Jupiter and Mars will bear this power. For the moon, a power of 45 will be found best for objects close to the terminator, but for those seen under high illumination, as when the moon approaches full, a power of 60 or even 90 should be used. Occasionally, in very steady air, a telescope will bear still higher powers than these; but it is rarely, and even when it does, no more can be seen with the higher power than can be made out with one of 90 to the inch. It is therefore always a mistake to employ too large a magnifying power.

For use with a micrometer, powers of 20 and 50 to the inch are the most useful, the former for general work, the latter for exceptional work, as measurement of very minute objects, close double stars, or the diameters of the planets. Ordinary micrometers can only be used with telescopes fitted with clock motion, unless the observer be exceptionally ingenious. A very convenient form of micrometer can be employed, however, for measuring other than very small distances. This is called the triangular micrometer, and is used for determining the difference between the right ascension and declination of two points; so that if the right ascension and declination of one be known, that of the other can be ascertained. It consists of an ordinary eyepiece with a large field, and magnifying about 15 to the inch of aperture, and is fitted with a system of four thin wires, arranged in the form of a triangle, as shown in fig. 109. Two of the wires are placed close together and parallel to each other, as shown at *a b*, and

FIG. 109.

they are crossed by two others, *d c* and *e c*, which meet in a right angle at *c*, a point midway between the two wires *a b*. This micrometer is used as follows: the telescope is clamped in a position such that one of the points whose distance apart is to be measured moves slowly across the field of view parallel to and midway between the pair of wires *a b*; then the time, T, at which the one point passes the cross of wires at *c*, and time, T′ T,″ at which the other crosses the wire, *d c* and *e c*, are noted in the same manner as the transit of a star is observed in a transit instrument. Then A, the difference in right ascension between the two points, will be equal to $\frac{1}{2}(T'' + T') - T$, and the difference, D, in declination is equal to $\frac{1}{2}(T'' - T') \times 15 \times$ cosine of the declination of the point whose position is known. From these the position angle and distance can easily be calculated. If either of the two points have a proper motion of their own, the amount of this motion must be subtracted or added to the above, according as it is in the same or opposite direction to the apparent motion of the heavens, but except in the case of the moon and sun, the amount of this motion is so small that it can generally be neglected. With this simple form of micrometer, distances can be measured with considerable accuracy. Any difference of right ascension can be measured, but that in declination is restricted to half a degree. Still greater differences in declination can of course be measured by the aid of some intermediate auxiliary star or point, by measuring in succession the difference in declination between the auxiliary point and the two objects on either side of it.

Shortly after one has begun as a telescopic observer, a sense of disappointment is apt to set in, for everything seems so much smaller than was anticipated, and so little seems visible as compared with what others have seen and described. The observer has, in fact, commenced to find out that he has to educate his eyes. Even those who have had considerable practice in other branches of telescopic work, experience the same sensation when they first turn their attention to new features. Thus the most experienced observer of double stars finds himself quite at a loss when he commences to observe planetary details. The wisest use, therefore, that a beginner can make of his telescope for the first two years, is to turn it first on one body and then on another until he can see what has already been seen by others with similar objects. A work like the "Celestial Objects" of the Rev. T. W. Webb forms a capital directory for this purpose. He thus learns how to best use his telescope, he gains experience in interpreting what he sees and in what to look for, and, above all, he educates his eye. Having at the end of this period learnt what others have already done, he is then better qualified to try and do something for himself. It should always be remembered that very little has ever been done in science by any one who was not familiar with the labours of his predecessors in the same field.

In employing one's telescope, the first thing to be remembered is, that if anything be worth watching it is worth noting. Make a note of everything done and seen. Every observation should be accompanied by full details, and the day and hour, instrument and power employed, and state of the weather, should be all stated. Further, if anything that is seen requires a description, in its turn the description should be accompanied by a sketch. It does not matter how rough and imperfect the sketch may be at first: before very long, certainly long before the two years of preliminary work be over, the knack of making tolerably faithful sketches will have been acquired. The sketch need not be artistically finished, but let it be as faithful as possible. In drawing any object first carefully put down the exact relative positions and dimensions of the main features, and then fill in the minor features. It is only in this manner that you can be sure that every part will be represented in its proper proportions. Where differences in tint or brightness have to be delineated, it will often be found advantageous to give each a kind of numerical value, or else carefully express their difference in words, and then insert them afterwards. Attempts to delineate them at the telescope, by mere shading, often lead to serious exaggeration.

The next point to be remembered is that, wherever possible, dimensions should be given. Thus, if a spot be seen on the sun or on a planet, its size should be given; if a star, its magnitude should be estimated, and so on. Further, in most cases the position should be noted—that is, its distance from two or more points whose position is known. This more especially refers to objects seen for the first time. These distances can generally be estimated by the eye if they are small, and if large they can be easily measured by the aid of the triangular micrometer already described.

Most observations, especially those involving measurement of distances and positions, require some auxiliary calculation to reduce them to the standard form employed by other astronomers: this reduction should be carefully done soon after the observation; and none should be published unless this has been done. Drawings of the aspect of planets, or different regions on the moon, should be accompanied by all information of this kind—as for example the phase of the planet, the libration of the moon, etc. More especially, every observation should be carefully dated; it is valueless without.

Instructions for making measures with ordinary micrometers, determining the true time, or the error of the clock, and for reducing the observations when made, will be found in most works on practical astronomy, as Lornie's "Practical Astronomy," which is a sort of standard inexpensive work.

Openings for Useful Work.—After mastering the preliminary difficulties of practical observation, and after having become familiar with the more striking beauties of the heavens, the time at length arrives when the observer becomes weary of purposeless labour and longs to direct his efforts towards making some serviceable contribution towards the advancement of the great science of astronomy, At first this does not seem difficult, for there seem to be great fields for exploration on every side; but when he proceeds to select some definite line of work, he finds all alike seem to elude him, for he does not know how to set to work. Though innumerable inchoate ideas seem to float around him, they all prove intangible when he seeks to grasp them, and from one and all alike he fails to elicit a single definite idea for working out to a successful end. Therefore, after having repeatedly failed to find anything by which he can realise his ideas of contributing to the advancement of astronomy, he is apt in sheer disappointment to think the task is beyond his power, and so gradually neglects his instrument for want of a definite object, and slowly loses his interest in the practical work he has undertaken. In this manner, many of those who have most enthusiastically taken to telescopic work have been lost to astronomy.

With the view of suggesting useful work for those who do not know in what direction to direct their labours, we propose to briefly indicate some of the different lines of special work which lie open for investigation in the different branches of practical work, and any of which might be taken up and carried out to a successful termination by a patient and careful observer, in possession of any telescope of moderate power.

The Sun.—This luminary does not offer much opening for merely telescopic work, and the little that there is to be done has now been under-

taken by several of the permanent observatories. The more special departments of solar work, such as the photographic and spectroscopic branches, require as a rule special apparatus not generally found in the possession of the ordinary observer. It would be of little avail, therefore, to particularise the opening for such work as remains to be done in connection with the sun.

Intra-Mercurial Planets.—The search for these bodies affords an opening for useful astronomical work, and one not unlikely to yield brilliant results. A watch should be kept on the sun, using high powers for minute circular dark spots, probably not more than 2″ in diameter. Should such a body be found, it should be carefully examined, to see if it be in moderately quick motion. Such a body would cross the sun in from two to six hours. Its position could be determined by timing the interval between the transit of the solar limb and the suspected body. If, however, such bodies exist, it is more likely that they would be found by systematically searching in the neighbourhood of the sun. Fine, clear, cloudless days should be taken—days when the sky is seen of a clear deep blue; and some time in the forenoon chosen, say between 9 a.m. and 12 a.m., as there is then little mist. A very long dew-cap should be fitted to the telescope. It is easy to construct one, in the shape of a tubular framework made out of long slender rods of wood, braced together at intervals by cross-pieces and covered with some thin dark material such as *alpaca*; such a dew-cap can be made ten feet long, and yet only three or four pounds in weight. If the telescope be fitted with such an appendage, it is easy to shut off nearly all the glare from the sun, and at ease carefully scrutinize its neighbourhood. Stars of the third magnitude can easily be seen on fine days in such a manner, when quite close to the sun. In the search for intra-mercurial planets, a region about twenty degrees long and three degrees wide on either side of the sun should be carefully swept over, and any star seen noted. Its place can easily be found by determining the interval between the transit over a wire in the eyepiece of the solar limb and the suspected body. Practice should first be gained by searching in this manner for Venus and Mercury when near the sun, it being easy to find out their exact position, so as to know where to look for them, should the previous search have failed to reveal them. Later, Mars should be looked for in the same manner. During this work it is not at all unlikely one or more comets may be detected on their approach towards perihelion, and so important extra discoveries reward the patience of the observer.

Mercury.—This planet is not one of those which afford much scope for telescopic work. Yet a good deal might be learnt from a long series of observations of the details of its surface, especially from midday observations with the aid of a long solar dark cap to the object glass. With Mercury, as with several others of the planets, as the observations are made under somewhat exceptioual conditions until the eye has gained considerable experience and has become used to the novel circumstances, very little will repay the trouble taken; but when the eye has been properly educated it will be found that there is a great deal more detail to be clearly seen than would at first be thought possible, or than can be seen by those inexperienced in this special kind of observation. When Mercury is near the sun, particular attention should be devoted to observing the irregularities in the border between the illuminated and unilluminated portions of the disc, and to seeing whether the horns or cusps of the illuminated limb are prolonged beyond the semicircle. If so, the amount of this prolongation should be noted, so as to determine the density of the atmosphere of the planet.

Venus.—The markings of this planet should be studied in daylight in the same manner as those of Mercury. If any spots be seen, their motion should be watched in order to determine the position of the equator and axis of rotation of the planet. The prolongation of the cusps of Venus which is visible whenever the planet is near inferior conjunction should be measured, so as to obtain a new determination of the density of its atmosphere (see *Monthly Notices of Roy. Ast. Soc.*, lxxxvii.). When Venus is between inferior conjunction and the epoch of greatest brilliancy, opportunity might be taken for searching for minute satellites. This of course must be done after sunset. Every minute star within a degree of Venus should be carefully mapped down, and then after allowing an hour to pass re-mapped to see if any have moved. As the position of the equator of the planet is not well known, this examination should be extended all round the planet. After some experience has been gained it will not be found difficult to map down in this way all stars brighter than the 11th standard magnitude, usually some thirty or forty in number. Another subject which might repay examination is the supposed phosphorescence of the dark side of Venus, by which it is seen as it were as a grey body against the darker sky.

The Moon.—A great field for useful work lies open to observers in connection with the moon—too great a field, in fact, for more than a small portion to be particularised here. For others reference must be made to the *Selenographical Journal*, the organ of the Selenographical Society, or to some standard work on the moon. With the aid of a simple micrometer (described in the *Selenographical Journal*, vols. i. and iii.), it is possible to continue and extend the determining of the position of the principal points on the lunar surface—an important work which much requires completion. In the same manner measurements might be made of the height of the different irregularities in the limb, and the position determined of the principal ones—a work which would be an important contribution towards perfecting the lunar theory. Another important question,

the amount and variations in the irradiation at the border of a bright object such as the limbs of the moon and planets, could be most easily studied by measurements of the distance of the lunar limb from some bright point on its surface near the edge. Again, much might be learnt by an examination of the supposed twilight at the cusps of the moon, seen by Schröter, Gruillmisen, and others, and regarded by them as indicating the existence of an atmosphere. Other work of a different kind consists in observing the variations in tint of different portions of the surface of the moon, and in the position of some of the bright streaks or radiations from some of the great formations, such as Tycho.

MARS.—The principal work to be done on this planet seems to be the re-determination of the position of its equator and axis of rotation by measuring the position of some well-marked point on its surface, such as the *Kaiser Sea*. This, however, would require a long series of measures with the aid of a powerful, well-appointed telescope. A search for exterior satellites might also repay the labour. Here, as the plane of the equator of Mars is well known, it would only be necessary to examine all the stars in a belt on each side of the planet—say, a belt extending for a degree on either side and a tenth of a degree in width. After experience had been gained, every star, down to the 13th magnitude at least, might be mapped in an hour; they would seldom exceed thirty in number. Then from two to four hours afterwards they should be again examined, to see if any had moved along with the planet, and so any satellite be detected. It would be useless looking within five minutes of the planet, on account of the glare.

THE MINOR PLANETS.—It would be worth while to carefully examine the region around one or more of the larger of these bodies, on the chance of discovering a satellite: success would be an important contribution to astronomy. The search might extend to all stars within half a degree, and down to stars of the 12th and 13th magnitude, perhaps some fifty in number; though it might be advantageous to confine oneself to a zone on either side of the orbit of the minor planet—a zone say a tenth of a degree wide. Useful work might also be accomplished by selecting a dozen of the smaller of these bodies, and on a dozen days at the opposition of each carefully determine their position with regard to some neighbouring bright star. To render this work complete it would be necessary to properly reduce all these observations, and determine the errors of the ephemeris. This work would form a sound, useful contribution to science; for many of the smaller of these bodies, being too faint to be easily observed in ordinary meridian instruments, are often not observed at all, so that they run a chance of being lost again. At least one has thus been lost and cannot now be found. This work, like all other astronomical work leading to exact results, possesses a charm which would not be anticipated by any one unfamiliar with it: the calculations involved are neither difficult nor laborious, and they may be made to lead to results of general interest and importance, by observing the distance of the planet from neighbouring stars, first when it is near the eastern and secondly when near the western horizon. Opportunity might be taken of favourable opposition for determining the solar parallax by the method already described. The search for new minor planets has ceased to be a work of much advantage.

JUPITER.—To those with powerful telescopes the principal work to be done in connection with this planet is to watch the changes taking place in the details of its belts. This is practically beyond any telescope of less than twelve inches aperture; much may be seen with far less powerful means, but not with sufficient completeness to render it likely that any discoveries will be made. The determination of the time of the rotation of the spots which are from time to time visible is a work which may well repay the labour bestowed on it. A search for a fifth satellite, lying about as far away again as the fourth satellite, but very much fainter, might lead to an unexpected discovery. Nor is it unlikely that another satellite may lie between the first satellite and the planet; but it is very faint, not brighter than the 10th magnitude, and so would not be readily discovered on account of the proximity of Jupiter, and consequent glare. The timing of the duration of the eclipse of the third and fourth satellites, when both the disappearance and reappearance can be seen, would throw much light on the question of the dimensions of Jupiter's atmosphere.

SATURN.—There is not much work to be done on this planet except by those provided with extra powerful or well equipped instruments. The observation of the conjunction of the two inner satellites of Saturn with the ends of the ring can be made with advantage, as furnishing data for improving the theory of their motion. Search might also be made with advantage for minute satellites in the great gap between Titan and Iapetus, but the work would be laborious. Observation could also be made of the ring with the view of determining the time of its rotation from any small spot seen upon it. There is little opening for anything else.

Uranus and *Neptune*.—These two planets are so distant, and consequently so minute in apparent dimensions, that little systematic work can be done on them except with very large instruments, say of twelve or fifteen inches aperture. Careful search with smaller instruments might very likely lead to the discovery of new satellites, especially in the case of Neptune.

Ultra-Neptunian Planets.—These suspected bodies and the method of searching for them have been already referred to. It is not unlikely that such a search might be successful, but it would certainly be laborious and long.

COMETS.—The search for comets, especially near the sun, affords one of the most useful departments of telescopic work, though one requiring a considerable amount of previous experience, or every small nebula may be taken for a comet. After a time, however, it is not difficult to learn to recognise at sight all the nebulæ in any given portion of the heavens, and then the search for new comets becomes facilitated. A portion of the heavens covering a space of about five degrees in right ascension and thirty degrees in declination should be selected, and every nebula in it examined until they become familiar to the eye—at first employing Sir J. Herschell's reference catalogue of nebulæ for identifying each. If this region be carefully swept over every clear night, it would ensure the detection of any comet crossing it. By selecting three such portions at intervals of about eight hours of right ascension, one if not two would always be suitable for examination on every night. At present the search for comets is not systematically carried out, and probably not one in ten of the comets which come to perihelion in the course of the year are detected. When discovered its apparent place should be fixed by reference to neighbouring stars, until one or more large observatories take up its observation. The computation of the approximate orbit of a comet, from three or more observations, is by no means a difficult work, requiring only a knowledge of the elements of spherical trigonometry. The observations of the details of the physical constitution of a comet cannot well be carried on except with very powerful optical means, and even then an observer must have a special knowledge of mathematical physics and chemistry before he can properly interpret the meaning of what he sees. It must always be remembered that it is useless to accumulate accounts of what is seen or thought to be seen, unless one can interpret in some degree the meaning of what is seen. No one else can properly do this from your account, and no one really competent to do so is likely to waste time in the attempt.

DOUBLE STARS.—The observation of these bodies usually possesses a considerable fascination for most observers, who naturally like to make their telescopes do all that has been done by others with similar instruments. This, however, is in no way a contribution to science, though undoubtedly a good training for the eye. Even the mere measurement of the distance and position angle of a few doubles is of little use to science. On the other hand, the selection of a few binary double stars, and their repeated measurement with the view of determining the orbit of the system, is a work of real utility. In such a case the observer should not rest content until he has mastered the art of calculating the orbits from his own observation.

STELLAR PARALLAX.—This is as a rule only within the reach of those observers with very completely mounted instruments. But much may be done by searching for stars which seem to have a large parallax. Likely stars—and binary double stars are the most likely—should have their position with regard to some small neighbouring star most carefully determined on several days at the two epochs in the year; once when they are on the meridian at about 8 p.m., and the other when on the meridian at about 4 a.m. If the mean of the distances at each epoch, when properly corrected, differ by half a second of arc, a measurable parallax may be suspected, and of course can be confirmed by repeating the measures. In any case the observation should be extended over several years, in order to make sure that the results of each year confirm one another.

NEBULÆ.—These present little, if any, opening for useful work, except to those who are skilful physicists, and possess their own special appliances. The mere discovery of nebulæ is no longer of any importance. The only work of any practical utility within the powers of the ordinary observer is the detection of the proper motion or parallax of some planetary nebula. The former could only be done by the work of a number of years; the latter might be carried out in the same manner as for detecting parallax in stars.

In the preceding a number of lines of work have been briefly indicated. The details necessary to carry them out have of necessity been omitted. But if any observer, who had duly qualified himself for the work, were willing to carry out any specified line of investigation, there are few more experienced astronomers who would not be willing to afford him the benefit of their advice as to the best means of carrying out his intention; and choice would naturally be made of one who had worked in the same field.

One thing is most important: it is useless to make and publish a mass of unreduced observations. No one can reduce these observations so well as their author, and no one will ever take the trouble to attempt it. Unreduced observations are practically wasted labour. The purchase of a work on practical astronomy will furnish all the information as to how the observations should be reduced, unless it be in an unusual line of work, and then it is only necessary to consult the labours of his predecessors to learn how to reduce these. In no case is it likely to demand more than an acquaintance with the rudiments of algebra and trigonometry; and a sufficient knowledge of these could be learnt in a month. Observations reduced and compared with any theory or hypothesis are of value; unreduced they are valueless. And with these important words we bring these articles to a close.

END OF "ASTRONOMY."

INDEX

ABBREVIATIONS.

Arithmetic . . . . *Ar.*	Friendly Counsellor . *Fr. Co.*	Machinery . . . *Mach.*
Astronomy . . . . *Astr.*	Geography, Political . *Pol. Geog.*	Mechanics . . . *Mech.*
Botany . . . . *Bot.*	Geology . . . *Geol.*	Political Economy . *Pol. Econ.*
Chemistry . . . . *Ch.*	German . . . . *Ger.*	Professions and Occupations . . . *Prof. and Occ.*
English Grammar . . *Eng. Gr.*	History, Ancient . . *Anc. Hist.*	Sound, Light, and Heat *Sd., L., & H.*
Electricity . . . . *El.*	History, Modern . . *Mod. Hist.*	Zoology . . . *Zo.*
English Literature . . *Eng. Lit.*	Human Anatomy . . *Hu. An.*	
French Grammar . . *Fr. Gr.*	Latin . . . . *Lat.*	

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